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Typical main drain running through residential areas in Accra

Margaret Armar-Klemesu

Balancing the Positive and Negative Health Impacts

Urban agriculture can have both negative and positive effects on the health and environmental conditions of the urban population. Previous reviews or studies of health issues have tended to highlight the health risks of urban and periurban agriculture (e.g. Birley and Lock 1999). This has served to reinforce the perceptions of many governments and municipal authorities that urban agriculture is a (marginal) activity that has substantial health risks and should not be supported.

Editorial

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In some countries, health and other concerns have led authorities to refrain from the planning and development of agriculture within city limits. There is often little dialogue between the health and agricultural sectors. Few health professionals are actively involved in agriculture, while agricultural practitioners do not normally consider health as a primary concern.

In this ongoing debate on the health effects of agriculture, policy-makers have often ignored the benefits urban agriculture can produce. These benefits to health and well-being are wide-ranging and include the reduction of urban food insecurity and improved nutrition of the urban poor.

Major health benefits of urban and periurban agriculture:
- increasing urban food security;
- improved nutrition;
- income generation and poverty reduction;
- improved sanitation solutions and waste recycling;
- improved physical and psychological health due to increased physical activity.

It is essential to address the health risks associated with urban agriculture not only to protect consumers and agricultural workers, but also to secure the support of municipal and national authorities for sustainable urban food production.

> The **benefits** of urban agriculture have **often been ignored**

The main health risks associated with urban and periurban agriculture:
- 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 wastes;
- human diseases transferred from **disease vectors** attracted by agricultural activity;

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Pesticide Soil Contamination: A Case Study from Perth Western-Australia

The safety of food produced in urban agriculture depends on a number of factors, including the history of persistent toxic chemicals applied to an area. Using the application of organochlorine pesticides in Perth, Western Australia as a case study, this article examines the problems that can arise when urban agriculture is scattered throughout a metropolitan area, and carried out by people who often have little detailed knowledge of how land in the area has historically been treated, and therefore what kinds of soil contamination might be present.

- contamination of crops and/or drinking water by **residues of agrochemicals**;
- contamination of crops by uptake of **heavy metals** from contaminated soils, air or water;
- transmission of diseases from domestic animals to people (**zoonosis**) during husbandry, processing or meat consumption;
- human diseases associated with **unsanitary postharvest processing, marketing and preparation** of locally produced food;
- **occupational health risks** for workers in the food-production and food-processing industries.

Many of these issues are discussed within this edition of the UA-Magazine. Pederson and Robertson, in their article, discuss the health benefits of urban agriculture and its role in urban food policies. The range of potential health risks of urban and periurban agriculture was discussed in the recent electronic conference on "Urban and Periurban Agriculture the Policy Agenda" organised by FAO and ETC-RUAF. A brief summary of the session on health and environment is given in the article by Lock and de Zeeuw.
The health risks associated with use of agrochemicals, from occupational handling to contamination of crops or water, are well known. The article by Gaynor explores the implications for food safety and the health risks of soil contamination by organochlorine insecticides in Australia. The article also raises questions about the responsibility of local authorities in informing urban growers of former land uses and the implications for their crops, livestock or consumers.
Two articles explore the health risks of urban livestock and fish farming. Zoonoses of dairy cattle are discussed in the article by Muchaal, which underlines that Bovine Tuberculosis and Brucellosis are often ignored as urban human health issues in Africa. Edwards discusses both pathogenic and chemical health risks from aquaculture in Asia. Recommendations are made to safeguard public health and to promote fish farming as a safe urban food source.

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Food Policies are Essential for Healthy Cities

Food production and its retail sales are increasingly perceived to be presenting risks to society in Europe. Consumers are concerned, and have lost trust and confidence in their food supply. Policies are therefore needed to limit the risks and to promote the assets of different means of food production and distribution, as well as to restore consumer confidence.

Dear Readers

Urban agriculture is practised to a substantial degree in many cities in the world. In discussions on a sustainable development of urban agriculture the positive and negative relationships play an important role, whether based on facts or on prejudice. Health is a major issue in this. There is indeed an obvious relationship between urban agriculture on the one hand, and the health and environmental conditions of the urban population on the other. This third issue of the *UA-Magazine* focuses on the relationship between urban agriculture and health.

Once again, the number of articles submitted to the magazine was high. We offer you ten articles on a diversity of topics surrounding the theme; food security, food policies, use of waste and wastewater and zoonoses. Unfortunately, a contribution on food security and nutrition was withdrawn at the latest moment. In order to fit into the magazine, some articles had to be cut down from the original. Only two- or three-page articles (1,700-2,500 words) are placed in the hard copy of the *UA-Magazine*. The RUAF website provides more room for longer articles, while also contributions that could not be included in this hard copy issue are shown on www.ruaf.org.

The guest editor for this issue was Karen Lock, from the European Centre on the Health of Societies in Transition, at the London School of Hygiene and Tropical Medicine. Karen was also involved in the Electronic Conference, on which she reports together with Henk de Zeeuw. Further support was received from Marianne Lindner, from the ETC Health Group, who recently finished an analysis of key issues in urban health and health-care in developing countries.

No articles were submitted on how urban agriculture can increase the risk of malaria. This topic created a lively debate in the framework of the E-conference, in which it was felt that urban agriculture initiatives should be co-ordinated with malaria control efforts in order to encourage sound environmental management practices. In relation to this important subject, we suggest that you read about the CGIAR System-wide Initiative on Malaria and Agriculture (SIMA) in the section on Networking. Malaria causes considerable adverse impacts on the population health and development of many countries, especially in Africa. A summary of opportunities for the reduction of malaria risks through agriculturally based interventions, proposed by SIMA is given on page 11.

One of the major concerns among urban agriculture practitioners, is the health risk linked to the use of wastewater and solid waste. Five articles address these issues from different perspectives. Furedy discusses solid waste re-use practices, and argues that self-help projects are the major answer to minimising health risks, because of the apparent lack of interest and capability by authorities to intervene at a policy level. Blumenthal et al. discuss an institutional approach to reducing pathogenic risks of wastewater re-use and propose new wastewater treatment guidelines for agricultural use. They advocate using the guidelines not as absolute standards, but as a guide for decision-makers on which water treatment processes, crops and irrigation methods are appropriate for safe production. The authors present an adapted version of the WHO guidelines of 1989. Two articles from Africa, one by Sonou on Ghana, and the contribution by Diop Gueye and Sy on Senegal, show the important contribution that wastewater irrigation makes to agricultural production in African cities. Both

Starting in 2001, the *UA-Magazine* is translated into French and Spanish, and is distributed through the RUAF Regional Focal Points in Asia, Africa and Latin America. This makes the readership substantially higher than the originally registered readers at RUAF in Leusden. At the moment we send the *UA-Magazine* to about 4,000 addresses.

You are invited to contribute to future issues of the *UA-Magazine*. Firstly, please note the call for contributions to the next two issues, at the end of this magazine. Secondly, any suggestions you might have for topics for 2002 are welcome. Issues that are thus far being considered for 2002 are:

- Economic and marketing aspects of urban agriculture;
- Transition to ecological urban farming;
- Rural-urban linkages (nutrient cycles, transportation, etc.); and
- Training in urban agriculture.

Submitted articles should be written in such a way that those working with farmers would readily be able to understand them. Articles would ideally be up to 2,500 words in length, and preferably accompanied by illustrations (digital if possible), references and a good abstract. Articles will be examined for selection by the editorial team consisting of the responsible editor and the external scientific advisor/co-editor.

Looking forward to hearing from you.

The Editor

Public Health Issues of Wastewater-fed Aquaculture

Fish farmed in wastewater-fed ponds provide nutritious and relatively safe food for the urban poor. In spite of most systems being developed by farmers with limited attention to either wastewater treatment or to public health, potential threats from disease-causing organisms and chemical contaminants from industrial effluents are mitigated by various mechanisms. Recommendations are made to further safeguard public health.

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In this issue

contributions acknowledge the health risks associated with wastewater use, and propose locally appropriate health-protection measures, including increased farmer education and training. Finally, Esrey and Andersson explore the potential of ecological sanitation as a local approach to solid waste re-use. Wider social acceptance of this practice has not yet been clearly demonstrated, but it is a good example of a process that explores sustainable solutions which attempt to protect both the environment and human health.

Tools to improve integration and participation are needed

Although the majority of contributions of this edition focus on health risks, the intention is to present a balanced view of the positive and negative health impacts caused by the practice of urban and periurban agriculture worldwide. Despite prohibitive laws, agriculture is practised in most cities in developing and transition countries. Although some of the articles discuss ways of mitigating health risks, the debate about the underlying reasons that people currently do not practice safer agriculture needs to be taken further. For instance, whether practitioners have access to adequate information on safer practices, and whether they would be helped by appropriate education schemes; or are poverty and lack of resources the main limiting factors? Or, is it possible that people grow certain crops for cultural or other reasons even if the health risks are known? Until we can elucidate some of the underlying reasons why people continue with farming practices that increase health risks, we may not be able to provide effective solutions at a local or national level. This appears to be an important area that needs further research.

The risks of urban agriculture should be addressed both in self-help schemes at a community level, and also in municipal or national policies and programmes that actively seek to reduce the negative health impacts while promoting good health. There does not appear to be an obvious mechanism of securing the support of policy-makers to implement these solutions. Urban agriculture practitioners need to find ways of

RUAF

The Resource Centre on Urban Agriculture and Forestry (RUAF) aims to facilitate the integration of urban agriculture in the policies and plans of city authorities and to facilitate the formulation of projects on urban agriculture, with active involvement of all local stakeholders.

The RUAF programme is administered by IDRC (within its 'Cities Feeding People Programme'). The leading implementing organisation is ETC International, based in Leusden, the Netherlands.
ETC co-ordinates the activities of four regional focal points, TUAN, City Farmer Network and other organisations participating in the Programme. Agreements have been established with the following ***Regional Focal Points on Urban Agriculture***:

- **Latin America and the Caribbean:** the Urban Management Programme (*UMP-LAC)* in Ecuador
- **Western Africa:** the Institut Africain de Gestion Urbaine (*IAGU*) in Senegal
- **Eastern and Southern Africa:** Management Development Programme (*MDP-ESA)*, in Zimbabwe
- **South-East Asia:** the International Board for Soil Research and Management (*IBSRAM)*, in Thailand
- **Middle East:** TUAN has taken the initiative to start up the process (see networking section in this issue).

These institutions will initiate activities, be responsible for the distribution and translation of the *UA-Magazine*, and participate in further activities under RUAF.

RUAF maintains close *working relations* with other networks and relevant international programmes. The duration of the RUAF project is five years, having started in October 1999.

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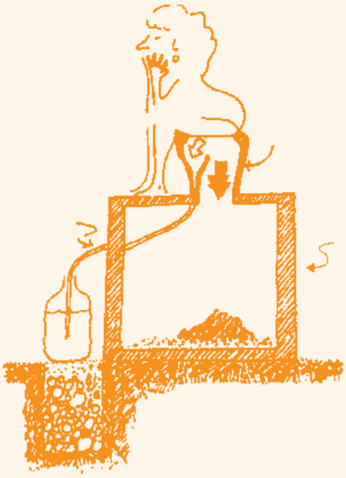
Reducing the Health Risks of Using Wastewater in Agriculture

Urban agriculture depends on water supplies for the irrigation of crops. Water is often extracted from rivers, and these may be contaminated with wastewater, discharged into the river with little or no prior treatment. In some areas, untreated wastewater is used for irrigation directly. Use of both can increase the risk of diseases for farm workers and their families, and for the consumers. Policy makers and farmers need to know what quality of water they can use.



Ecological Sanitation: Closing the Loop

Ecological sanitation, through urine diversion, may contribute to food security, less pollution, better resource management of water, nutrients and soil. It is likely that it can also contribute to health and well-being in two direct ways: less transmission of disease, by killing pathogens at the source, and increased food security, by increasing nutrient intake. It is far more feasible financially and ecologically than conventional approaches.

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actively engaging and working with governments and municipalities in a better, planned way. A Health Impact Assessment is an evidence-based, decision-making tool that could help (Lock 2000). It has been used in other policy sectors including urban planning, water resource management, and transport, to involve stakeholders in a process with authorities to promote health.

Health Impact Assessment has been proposed as a prospective method for assessing and improving the health consequences of projects and policies in non-health sectors, such as agriculture. It aims to influence the decision-making process in an explicit, structured way by balancing objective evidence and subjective opinion. It is a multidisciplinary process, and promotes community participation in decision-making. Potential health impacts identified by an assessment are analysed and used to influence the decision-making process (Lock 2000, Birley 1995).

The principles of Health Impact Assessment are similar to environmental impact assessment. But, although many countries have legal requirements for carrying out Environmental Impact Assessment, very few environmental assessments explicitly consider human health. Health Impact Assessment has been developed as an independent tool for promoting public health in policies and projects.

Several countries have established policy frameworks for Health Impact Assessment, such as The Netherlands, Canada and Australia. In developing countries, Health Impact Assessment has mainly been developed as a rapid appraisal tool for environmental development projects (Birley 1995). The likelihood of specific health risks related to a project is considered and risk reduction strategies are proposed.

Health Impact Assessments have been used in various projects including of those of the World Commission on Dams (agricultural and water resource development projects for donor agencies) to mitigate health risks to the affected population (Konradsen et al. 1997). Guidelines and training have been developed by some international organisations including the Asian Development Bank and the World Bank (Asian Development Bank 1992, World Bank 1997).

Most of the recommendations of Health Impact Assessments that have been implemented have resulted in improvements both to the environment as well as the population. The wider implementation of health impact assessment has been slow because of the lack of political will in making health an important focus in decision-making. There are still some limitations to the methodology. Practitioners should be aware that there is not one 'gold standard' and that the methodology for Health Impact Assessment is still in the process of being developed and evaluated. An assessment can also be limited in the certainty of its findings due to the lack of good quality evidence to support some of the possible health impacts. The evidence base for Health Impact Assessment is continually being built up. Despite these limitations, Health Impact Assessment has proved to be a powerful lobbying and decision-making tool at the local and national policy level.

Continue to work towards local low cost solutions

Those involved in the development of urban agriculture should continue to work towards local, low cost solutions to protect consumers and agricultural workers against possible health risks. It is equally important to engage policy-makers at a municipal and national level. Health Impact Assessment is one multisectoral tool that can be used in urban planning to bring health professionals, agriculture practitioners and municipal planners together for integrated solutions.

RUAF is a global initiative of the Support Group on Urban Agriculture, co-ordinated by ETC

This article focuses on the discussion from the UPA Health and Environment session of the E-conference. The effects of UPA on the environment were also discussed but will not be included here.


Margaret Armar-Klemesu

Cleaning of vegetables, ready for retail in Accra

Mitigating the Health Risks Associated with Urban and Periurban Agriculture

Results of the E-conference 'Urban and Periurban Agriculture on the Policy Agenda'

Like rural agriculture, urban and periurban agriculture (UPA) entails risks to health of the urban population if not managed and carried out properly. City authorities have often been reluctant to accept urban agriculture because of perceived health risks. Rather than general laws prohibiting urban agriculture, which are largely ineffective, policies are needed that actively manage the health risks related to urban agriculture.

To formulate urban agricultural policies that improve the health of the urban population, it is important to have a good overview based on research and practical experience. We provide an overview of the main health risks associated with UPA (see table) and the main mitigating measures that have been proposed during the recent E-conference or from the literature.

OVERVIEW OF THE MAJOR HEALTH RISKS ASSOCIATED WITH UPA

A review of the available literature and the discussion in the Health and Environment discussion group indicates that, although insight into the potential health risks of urban and periurban agriculture is growing, detailed information on the actual health impacts of UPA is scant. Many of the health risks indicated in the table on page 8 are not specific to UPA and much of it is taken from agricultural literature.

MITIGATING HEALTH RISKS

In order to develop effective policies to mitigate the health risks of UPA, it is necessary to develop a good insight into:

a. the environmental conditions under which the health risks associated with UPA occur (including physical geography

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Introduction

A virtual conference on 'Urban and periurban agriculture on the policy agenda' was jointly organised by FAO and ETC-RUAF, from August 21 - September 30, 2000. The conference was divided into three main themes: Household Food Security & Nutrition; UPA, Health & Environment; and UPA and Urban Planning. The first two of these directly discussed the population health effects of UPA. The session on household food security focused on the improvements that UPA can make to diet and nutrition. The session on UPA, Health & Environment mainly focused on the health risks of UPA and discussed policies at city and national levels that prevent or mitigate such risks.

The conference attracted 720 participants from 45 countries. The food security and nutrition discussion had a total of 290 participants, while the health and environment group had about 210. In addition to a large overall number of participants, there was very active exchange between South and North, as well as evident South-South dialogue. In addition to sharing their own experiences and responding to questions posed by the moderators, these participants learned directly from each other's experiences.

The introductory and final papers, and the discussion of the E-conference can be found on the RUAF website: www.RUAF.org and the FAO website: www.FAO.org/urbanag.

and climate, farm management practices, marketing chains);

b. the biological and epidemiological aspects of the health risks that have been identified;

c. the factors that currently restrict the urban poor from engaging in safer agricultural and food practices; and

d. the capacity and willingness of city authorities to implement certain policy measures taking into account restricted financial and human resources and the actual socio-political conditions.

The range of measures proposed is summarised below.

Diseases associated with re-use of urban wastes and wastewater:

- adoption of waste re-use policies for urban agriculture which are based on health criteria;
- identification of quality standards for municipal wastes and composts produced from them;
- cropping restriction in areas where wastewater is used but water quality cannot be guaranteed; certification of safe production areas;
- improved composting facilities and methods: prevention of mixing household waste with that of hospitals and non-agroindustries; promotion of adequate composting methods (temperature, duration) to ensure the killing of pathogens;
- application of wastewater-treatment technologies that effectively remove pathogens but maintain the nutrients dissolved in the water (e.g. waste-stabilisation pond systems rather than sludge-treatment plants) and have low maintenance costs;
- farmer education on management of health risks (for workers and consumers) associated with re-use of waste in agriculture, including crop selection, irrigation and reducing occupational risks; and
- consumer education (washing of fresh salads; eating only well-cooked vegetables, meat and fish from wastewater-fed crops, animals and ponds).

Design of **effective measures requires collaboration**

Vector-borne diseases:

- control programmes for vector-borne disease based on environmental management should involve co-operation between the health, agriculture, irrigation and waste sectors;
- reduction of malaria risk in African cities by:
  a. suitable selection of crops (rice, sweet potatoes, cassava and yams are high risk); and
  b. good drainage of surface water; adequate design of water tanks and irrigation systems (especially in periurban areas).

Diseases associated with use of agrochemicals:

- promotion of ecological farming practices and replacement of chemical pest and disease control by Integrated Pest and Disease Management (IPM);
- farmer education on the proper application and handling of agrochemicals;
- introduction of cheap protective clothing and equipment;
- better control of banned pesticides; and
- better monitoring of the effects of agrochemical accumulation in water and soils.

Diseases associated with soil and water contamination with heavy metals:

- monitoring of agricultural soils and irrigation water for heavy metals;
- crop restrictions according to type and level of contamination of agricultural soils and water;
- treatment of contaminated soils with farmyard manure, lime, red mud or iron oxide and zeolites for immobilisation of (certain) heavy metals;
- use of plants like Indian grass (*Brassica juncea*) for biological remediation of polluted soils or streams and
- washing and processing of contaminated crops, which may effectively reduce heavy metal content.

Zoonotic diseases:

- restriction of uncontrolled movement of livestock in urban areas (e.g. by promotion of stall feeding) and/or improvement of the urban waste-collection system;
- composting of manure before application;
- consumer education regarding thermal treatment of all dairy products and proper cooking or freezing of meat products; and
- strict slaughterhouse regulations.

The health risks and mitigating measures suggested during the E-conference should be seen as working hypotheses that need further research. There is no directly comparable information about the burden of disease for each of these categories of health risks. We can only estimate the relative importance for human health. Longer term monitoring of the health impacts of the various types of UPA under diverse environmental conditions, and the success of the suggested mitigating measures is needed.

The participants to the E-conference discussion group on UPA, Health and Environment stressed that the design of effective measures requires close co-operation between the health authorities, agriculturists, land-use planners and municipal authorities. A multidisciplinary and participatory approach in the planning and implementation of solutions to the problems is advocated.

Urban planners need to involve UPA practitioners in designating agricultural land use that takes into account the health and environmental risks of each type of farming and the local environmental conditions.

Schilder and Kusiaku

Market in Lomé

Local government authorities and decentralised agencies have a role in monitoring the quality of soils and irrigation water used in UPA; collaboration with malaria-control programmes; and co-operation with agricultural extension programmes to educate farmers.

Summary overview of major health risks UPA

	Communicable diseases	Non-communicable diseases
Crop production	*1. Crops irrigated with untreated (or inadequately treated) domestic wastewater or fertilised with improperly produced compost may be infected with bacteria (shigella, typhoid, cholera), worms (like tape- and hookworms), protozoa, enteric viruses or helminths (ascaris, trichuris).* *2. In Africa, mosquitoes that are the vector for malaria may breed in clean, shallow irrigation water and crop land with serious waterlogging. Incidence of malaria mainly relates to wet rice and ridge cultivation of yams and sweet potatoes.* *3. Mosquitoes that are the vector for filariasis may breed in standing water heavily polluted with organic materials (drains blocked by organic refuse, latrines, septic tanks).* *4. Mosquitoes that are the vector for dengue breed in water containers that include much solid waste, like coconut husks, rubber tyres, water storage jars, buckets and water-butts.* *5. Food may be contaminated with bacteria due to poor hygienic conditions in informal food preparation and marketing, causing diseases such as salmonella and E-coli.*	*1. Crops may take up heavy metals and other hazardous chemicals from soils, irrigation water or sewage sludge polluted by industry.* *2. Crops grown close to main roads or industry, and food purchased from street vendors may be contaminated by air-borne lead and cadmium.* *3. Residues of agrochemicals may contaminate crops or drinking water (pesticides, nitrates).* *4. If waste materials are not separated at source, the resulting compost may contain heavy metals, which can be taken up by crops.* *5. Occupational injury of agricultural workers is an important source of disability including musculo-skeletal disorders or poisoning by agrochemicals.*
Animal husbandry	*1. Closeness of animals and humans may lead to occurrence of zoonotic diseases like bovine tuberculosis (cattle) and tapeworms especially when animals are scavenging waste tips.* *2. Drinking water may get contaminated with pathogens by application of animal waste (e.g. slurries) to land.* *3. Animal products can become contaminated with pathogens due to contamination of animal feed with infected faeces (salmonella, campylobacter).*	*1. Animal products (like red meat, poultry meat and eggs) may be contaminated with pesticides (especially organo-phosphates) and/or antibiotics, if animals are kept intensively.* *2. Freely wandering animals can injure people and may cause traffic accidents.* *3. Allergens from livestock wastes/dust (esp. poultry) can cause occupational diseases in farm workers (asthma, allergic pneumosis).* *4. Tanneries may discharge hazardous chemicals in their wastes (tannum, chromium, aluminium).*
Aquaculture	*1. If fish (especially shellfish) are fed with wastewater and/or human and animal excreta, there are potential risks of :* *a. passive transfer of pathogens (hepatitis A) by fish and aquatic macrophytes; and* *b. transmission of trematodes whose life cycles involve fish and aquatic macrophytes. This is only a problem where trematodes are endemic and fish is consumed raw.* *2. Contamination of fish with human or animal faecal bacteria may occur during post-harvest operations (e.g. salmonella).* *3. Poorly managed fish ponds may become a breeding ground for malaria mosquitoes.* *4. Use of antibiotics in fish feed may lead to development of antibiotic-resistant bacteria in the food chain.*	*1. Fish products may be contaminated with heavy metals if fed with wastewater or organic wastes contaminated by industry.* *2. Fish products may be contaminated with agrochemicals, if produced in an input-intensive way.*

Food production and its retail sales are increasingly perceived to be presenting risks to society in Europe. Consumers are concerned, and have lost trust and confidence in their food supply. Policies are therefore needed to limit the risks and to promote the assets of different means of food production and distribution, and also to restore consumer confidence.

Antoaneta Yoveva

Market in Sofia

Food Policies are Essential for Healthy Cities

Food security is defined as "all people at all times have physical and economic access to enough food for an active, healthy life." This concept encompasses the belief that production, distribution and consumption of food are sustainable and governed by social justice and values that are equitable and morally and ethically sound; the ability to acquire food is assured; food is nutritionally adequate, and personally and culturally acceptable; and food is obtained (and consumed) in a manner that upholds basic human dignity (working definition of Food Security, World Food Day Association of Canada 1995).

Maintaining food security in a way that is both sustainable and ethically sound for the increasing number of people living in cities, is a challenge. The level of urbanisation in the European Union (EU) is around 80% compared with 66% in Central and Eastern Europe. It is predicted that 90% of all Europeans will be living in cities by the year 2015. How food is produced and retailed to this large population is a matter for serious attention by policy-makers.

Urbanisation combined with global food production and retail-level sales can detrimentally affect food and nutrition security unless appropriate policies are made. Within a European context, local food policies could provide part of the solution and reduce the problems. Urban agriculture is seen as an increasingly important means of attaining local food security.

FOOD-RELATED URBAN HEALTH ISSUES

There are three key health issues which urban food policies need to address: food safety, inadequate population nutrition and socio-economic differences in food availability.

In Europe, discussions on the health effects of agriculture have been dominated by food safety issues although the effects of agriculture on nutrition are quantitatively more important for population health. Food production, its sales and food-borne disease are increasingly perceived as presenting public health risks. Consumers are increasingly concerned about microbiological safety (Campylobacter, Salmonella, *E. coli*, and Listeria), chemical safety (pesticide residues, nitrates and heavy metal contamination) and genetically modified food, novel foods and new processing techniques. Consumer confidence has suffered due to reports about antibiotic resistance, mad cow disease (BSE) and dioxin scares.

Many of the food-borne diseases are associated with mass-produced food. Some of the risks might be more easily controlled and potentially reduced if more food is produced closer to the consumer. However, many municipal authorities are at times unnecessarily restrictive in terms of the retail sales of local foods. Despite this, local foods in some countries in Central and Eastern Europe contribute substantially to the availability of vegetables and fruit, and provide a way to earn extra income. Local markets must therefore be preserved at all costs.

Diet and nutrition have clear health linkages. A diet which is low in vegetables and fruits is associated with an increased risk of cardiovascular disease. Estimates suggest that 30–40% of certain cancers can be prevented by eating enough vegetables and fruit (WCRF 1997). A low intake of vegetables and fruit is also associated with micronutrient deficiencies, hypertension, anaemia, premature delivery, low birthweight, obesity, diabetes and cerebrovascular disease (WHO 1990).

The WHO, and EURO's CINDI dietary guide to healthy eating, recommends eating *at least* 400 grams of vegetables (not including potatoes) and fruit daily (WHO 1990). More than half of the 51 countries in the WHO European Region do not currently produce a sufficient amount of vegetables and fruit to support this recommendation. It has been estimated, using FAO's food production data,

Much of this article is based on WHO EURO's Urban Food and Nutrition Action Plan. This provides more detail on the potential assets arising from local food policies as well as many examples. For more information on WHO, activities please visit our website (www.who.dk/nutrition/main.htm) or write and ask for more information.

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that 600 grams of vegetables and fruit per capita per day (needed to secure an intake of 400g/person/day) were available only in 11 countries in the European Region (Belgium, France, Greece, Israel, Italy, Luxembourg, Malta, The Netherlands, Portugal, Spain and Turkey) in 1995. The question is how to increase the availability of and access to enough vegetables and fruit for all urban dwellers.

Urbanisation and urban food access may contribute to poverty and socio-economic inequalities. Poverty is associated with poor health and an increased risk of disease. Current policies may not support retail outlets to sell affordable vegetables and fruit. Supermarkets are increasingly built on the periphery of cities making regular access, especially for vulnerable groups such as the elderly or disabled, difficult. Street markets, food co-operatives and community schemes that bring producers closer to their customers may be non-existent.

Local urban food policies promote the benefits of urban agriculture

The population of Athens have access to fresh vegetables and fruits at traditional street markets where farmers, market gardeners, and even households sell their produce in almost every neighbourhood. Greece, which has the greatest amount of vegetables and fruit available nationally, also has the lowest rate of premature death from heart diseases. Data from household budget surveys show that twice the amount of vegetables and fruits (600 grams) is available at the household level in Greece, as compared to only 300 grams in Russia. This low availability is bound to result in inequalities and very low intakes for the poor living in St Petersburg, compared with Athens.

THE POTENTIAL HEALTH BENEFITS

Fortunately, periurban and urban conditions are conducive to the production of vegetables and fruit. Increased growing of these nutrient-dense foods will make an important contribution to urban food and nutrition security. Production closer to cities helps to ensure that the produce is as fresh as possible and likely to have a higher nutrient content, compared with that which is stored or transported for long periods (Lobstein 1999).

In Central and Eastern Europe and the former Soviet countries, while output from large-scale collective farms has decreased, local food production is rapidly increasing (Box 1). In order to ensure food security and supplement income during times of social and economic hardship or war, people start growing their own food. For example, during the Second World War, people in Britain were urged to 'Dig for Victory,' and more recently, similar activities occurred in Sarajevo during the 1992-96 war (Curtis 1995). Even in Western Europe, urban food production is increasing; for instance, the City Harvest Project in London estimated that almost 20% of the WHO recommended vegetable and fruit intake could be produced in the city.

Local urban food policies promote the benefits of urban agriculture for increasing food security and other health improvements. Incentives to produce more food locally and to sell it at affordable prices through healthy market places could help reduce poverty and social inequalities. The percentage of income spent on food is much higher in Central and Eastern Europe (up to 60-70%) compared with the EU (20%). Inequitable access to food will get worse if local food policies are not implemented. The cost of local foods may be lower than globally mass-produced foods because of savings on transport, storage, fewer middle-men, less processing and packaging. Any savings made on food expenditures by the poor translates into more income and are available for improvements in living conditions.

Box Examples of urban food production in WHO European Region

- ❖ In Russia town dwellers produce 88% of their potatoes. These are grown on plots of 0.2-0.5 hectares which constitute only 4% of the agricultural land in Russia .
- ❖ In Poland 500,000 tonnes of vegetables and fruits (1/6 of the national consumption) were produced on 8,000 council gardens in 1997.
- ❖ In cities of the former Soviet Republic of Georgia home produced food made up 28 % of the income.
- ❖ In Romania the share of home produced food rose from 25 to 37% between 1989 and 1994.
- ❖ In 1998 in Bulgaria 47% of the urban population was self-sufficient in fruit and vegetables; 90% of families prepared preserves for the winter.

Source: Urban Food & Nutrition Action Plan, WHO, EURO 2000.

Other benefits of urban food policies include direct economic benefits arising from income generation, local employment and the development of small enterprises, and indirect economic benefits arising from more opportunity for education, recreation, and the multiplier effect of attracting new businesses and services. There are also many environmental benefits including water and waste reuse. (For more on benefits of increased vegetable production, see Knai & Robertson, Horticultura, 2000 (in Spanish and English, from WHO EURO.) These benefits come on top of social benefits, including increased leisure possibilities, improved social cohesion and inclusion, and the health benefits of improved physical and mental well-being.

THE NEED FOR LOCAL URBAN FOOD POLICIES

Governments at local and national levels need to create explicit policies to improve safe access to food and nutrition in urban areas. Many urban health and environmental problems have similar solutions. Local urban food policies seek to increase the availability of and access to locally produced foods and at the same time improve the local economy, create more jobs and promote social cohesion by linking urban dwellers more directly with growers. Moreover, incentives can be given to produce food using environmentally sound and sustainable methods.

Municipal authorities involved in environment, health and community development are beginning to link these different issues, through projects or networks. NGO projects aiming at poverty alleviation, urban renewal and community development, Healthy Cities networks and Local Agenda 21 initiatives can all be linked through food projects to improve nutrition security. One example is the St Petersburg Urban Gardening Club (Garilov 2000).

The successful implementation of food policies requires the participation of various stakeholders: local/municipal authorities, food producers, consumer groups, neighbourhood and environmental groups, local schools, community health centres, retailers, markets, banks and food control/safety authorities. Community involvement, both to find sustainable

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solutions and to facilitate action, is essential. Although ensuring broad community involvement is daunting since it is both time and resource consuming, it is vital to ensure equitable and sustainable solutions. This requires public debate, and also effective interaction between policy-makers, institutions, commercial interests and community groups. The family allotment gardening scheme in Georgia illustrates the problems and benefits of community involvement in implementing local food projects (Chatwin 1998). This pilot project involved the community, local authorities and NGOs and was proposed as an institutional mechanism for increasing urban food security, with a secondary aim of democratic institution building. Forty of the poorest families were allotted a 250m² plot of land and they were organised as a (community-based) group to manage this as family allotments. Despite many disputes among participants, the benefits of the approach led to assessment of the model for its potential application to other urban areas of Georgia and the Caucascian region.

The creation of mechanisms, such as Community Food and Nutrition councils, will help to develop and implement local food policies and ensure an integrated approach. These councils should be organised by the local/municipal authorities with representation from local food producers, retailers, public interest groups working with the environment and community development. Community Food and Nutrition Councils could provide a local framework for: identifying objectives and strategies; monitoring community-based projects; co-ordinating research into sustainable agriculture, urban planning, community development, and reviewing and updating food and nutrition policies.

CONCLUSION

The health risks associated with urban food production and retail sales need to be minimised while more attention should be paid to potential health benefits. The objective of urban food policies should be to promote health through an integrated approach within the local community. Health - including physical and mental well-being - and socio-economic gains achieved could help reduce the widening gap in social inequalities in many cities.

Clearly there are major differences within and between cities. However, important lessons and appropriate actions can be learned by sharing these differences. Action requires the participation and collaboration of citizens, voluntary organisations, retailers, wholesalers, food producers and the local authorities and politicians. Local Agenda 21 and Local Environmental Health Action Plans are being implemented in Europe, which provide a platform for participation.

Implementing local food policies which advocate sustainable food production and equitable distribution, provide a concrete way of improving public health. Growing, buying, and eating the right kinds of food can reduce the risk of major diseases and simultaneously promote a sustainable urban environment.

Designing a Research Agenda on Malaria and Agriculture

Over the last decades, a considerable investment of financial resources has been directed towards the development of curative drugs and vaccines against malaria, and towards the evaluation of chemical insecticides for mosquito control. Historically, the agricultural dimension has received little attention from the research community, despite its importance as a contributory factor to malaria transmission risks and its inherent opportunities for paradoxically minimising such risks. The incorporation of a relevant health component in agricultural research could contribute to the identification of opportunities for minimising malaria risks through agriculturally-based interventions, both in rural and in urban and periurban settings. **The CGIAR System-wide Initiative on Malaria and Agriculture (SIMA)** co-ordinated by the International Water Management Institute (IWMI) (see the Networking Section in this issue) has taken up this challenge.

How can agricultural interventions help reduce malaria? Some practical examples:

❖ Problem → Flooding of rice fields promotes mosquito breeding. *Opportunity* → Intermittent irrigation may increase rice yields and control mosquito breeding.

❖ Problem → Cattle expand mosquito populations through provision of blood meals and creation of vector-breeding habitat. *Opportunity* → Cattle can be used to divert hungry mosquitoes from people (zoophrophylaxis). They are also 'dead-end' hosts to malaria parasites.

❖ Problem → Pesticides used in production of high-value crops induce insecticide resistance in malaria mosquitoes and can also lead to acute and chronic poisoning of people. *Opportunity* → Control of crop pests through integrated pest management (IPM) approaches may reduce the need for synthetic insecticides.

❖ Problem → Poor nutritional status contributes to low immunity against infections among children. *Opportunity* → Micronutrients (e.g. vitamin A in varieties of sweet potato, vegetables, etc.) may enhance immunity against infections, including those due to malaria parasites. *Opportunity* → Bucket-kit drip irrigation systems and treadle pumps may enhance food security and income (for purchase of nets, drugs, etc.) among poor households in Africa, Asia and Latin America.

❖ Problem → Synthetic fertilisers used for rice production cause a rapid increase in populations of important vectors of disease including malaria (Africa). *Opportunity* → Rice fields with freshly applied synthetic fertilisers may enhance the biological control of mosquitoes using *Bacillus thuringiensis israelensis* (Bti). First, by serving as important concentration sites for mosquito larvae. Secondly, by improving the timing of the application of the entomo-pathogenic bacteria, since peaks of larvae appear to closely follow fertiliser application in the field. Improved timing could increase the efficiency of applying Bti, thereby reducing costs.

The safety of food produced in urban agriculture depends on a number of factors, including the history of prior land uses and applications of pesticides or other chemicals on an area. In Perth, Western Australia, attempts to eradicate the Argentine Ant resulted in the widespread treatment of private suburban land with organochlorine insecticides. These pesticides are persistent in the environment and potentially hazardous to human health. They were also used by urban market gardeners and householders.

Chicken run on contaminated soil?

Pesticide Soil Contamination

a Case Study from Perth, Western-Australia

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One of the difficulties of the organochlorine pesticides is that they accumulate in fats. Even after the state programme of spraying for Argentine Ants ceased in 1988, unacceptable levels of pesticides were still being found in the eggs of domestic poultry kept in suburban backyards. The legacy of the Argentine Ant campaign and other organochlorine spraying continues even today, with residue levels in some cases nearing or exceeding the recommended levels. There is no systematic attempt made by any authority to warn people of the possibility of high residue levels in the eggs of backyard poultry, and no subsidised service for the testing of eggs for residues. So, ironically, people in suburban Perth who keep their own poultry in the belief that the eggs produced are 'cleaner' than the commercial alternative, may be getting more than they bargained for.

Organochlorines accumulate in fats

THE ORGANOCHLORINE PESTICIDES

Although safer for humans than the arsenical insecticides commonly in use prior to the Second World War, the organochlorine insecticides which achieved widespread popularity in the 1950s were by no means benign. One of the first organochlorines to be produced and widely distributed was DDT.

In the US, naturalists expressed concern over the potential environmental effects of DDT in 1944, before its general release to the public (Perkins 1980). Scientists were aware of some of the problems of persistence of organochlorines in the soil as early as 1958 (Dingle 1988). However, it was not until after 1962, when Rachel Carson published her research into the health and ecological effects of the new pesticides in *Silent Spring*, that many members of the public seriously began to question the wisdom of using such persistent and potentially dangerous chemicals.

In the 1950s, the organochlorine pesticides were widely regarded as a cheap, effective and unproblematic means by which to defeat virtually all insect pests, and they were used extensively.

Although it was widely accepted as safe in the 1950s, there is now a lot of debate over whether DDT is a human carcinogen. Currently, it is classified by the World Health Organisation as 'possibly carcinogenic to humans', as well as possibly having toxic effects on human reproduction. The United States Environmental Protection Agency regards it and most other organochlorines as probable human carcinogens[1]. One of the greatest concerns about DDT and other organochlorines - particularly for a species at the top of the food chain - is the fact that they accumulate in fats, including body fats, milk (including breast milk) and eggs. DDT also persists for a long time in the environment. It has a reported half-life of between 2 and 15 years and is fairly immobile in most soils, particularly those containing much organic matter (Extotoxnet 1996).

Dieldrin, Chlordane and Heptachlor are all cyclodiene insecticides, a type of organochlorine compound. Like DDT, they are very persistent in the environment, and tend to accumulate within food chains. Dieldrin, the most persistent of the cyclodienes, moves extremely slowly in soil and has a reported half-life range of 2-39 years (Gerritse 1988). The cyclodienes are toxic to birds, bees and fish, as well as to humans. Some have been shown to cause cancer in mice and are regarded as probable human carcinogens. They accumulate in human breast milk, and there is little knowledge of their effect on infants (EPAWA 1988).

THE ARGENTINE ANT ERADICATION CAMPAIGN IN PERTH

The Argentine Ant arrived in Western Australia in 1941, before organochlorine pesticides had achieved widespread usage. The ants became an acute household and garden pest, infesting pantries, dining rooms, even refrigerators, and overran chicken pens, sometimes killing birds. "In severe cases, bed legs were placed on vaseline-smeared plates or tins of water with a kerosene film, in order to stop the ants climbing onto the beds. The ants were particularly troublesome in the dry heat of Perth summers, as they invaded houses in their relentless pursuit of moisture".
In some Australian states, such as Victoria, control of the pest was carried out by local authorities on an 'as-needed' basis. In Western Australia, however, the response was legislative.

In 1954 a large-scale spraying campaign began under the *Argentine Ant Act*, with the aim of eradicating the pest within five years (EPAWA 1988). The campaign was based on the use of the organochlorine pesticide Dieldrin, with Chlordane being used in 'sensitive areas' such as around fish ponds and aviaries. The chemicals were sprayed around the perimeter of an infestation, and in grid lines spread three metres apart within the infested area. Later, when Heptachlor replaced Dieldrin and Chlordane, it was applied in grid lines spaced one metre apart, and Chlorpyriphos - a shorter-lived organophosphorus insecticide - was used for 'sensitive areas'. From the commencement of the campaign in 1954 until its suspension in 1988, between 234 and 4,857 hectares were treated every year. Some areas were treated repeatedly. Most of the spraying was carried out in the inner and middle suburbs of Perth, though the campaign also extended to some country towns. Although its spread was controlled, the ant was not eradicated[2].

The Act gave sweeping powers to 'authorised persons' to enter and inspect properties, and to spray, or require owners to spray, with prescribed chemicals to kill the ant. In Perth, some residents had doubts about the wisdom of allowing their properties to be sprayed for Argentine ants, and occasionally police gained entry by force where residents had refused to allow ant control personnel onto their properties (Dingle 1988).
Public concern over the use of Heptachlor for Argentine Ant treatment had reached substantial levels in Western Australia by the mid-1980s. DDT, already deregistered in the United States in 1972, was deregistered in Australia in 1987 only. In the same year, the cyclodienes were deregistered for agricultural use in Australia, after a well-publicised incident where the United States rejected Australian beef containing high levels of organochlorine residues (especially Dieldrin). However, cyclodienes continued to be used in a suburban context to kill termites and other pests, including Argentine Ants, and it was only in 1995, after a long campaign by community groups that they were deregistered for all uses in Western Australia.

Residue levels can exceed the limits regarded as safe for health

COMMON URBAN SOIL CONTAMINANTS

Due to their widespread use in the past and persistence in the environment, organochlorine insecticides including Chlordane, Aldrin, Dieldrin, Heptachlor epoxide, and DDT and its metabolites, are some of the most prevalent soil contaminants in urban areas. Other potential contaminants which are persistent in the environment include arsenic, mercury, lead, cadmium and PCBs:

❖ Arsenical pesticides were commonly used in fruit and vegetable production until they were superseded by organochlorines after the second world war. Arsenic may still be found at elevated levels on some old orchard and garden sites.

❖ Mercury was also used in pesticides, but is now more likely to appear as a soil contaminant in areas which have been used for the storage or disposal of certain types of batteries, paints, vapour-discharge lamps and electrical switches. Mercury may also be found in significant amounts in medical and laboratory waste.

❖ Lead is commonly found as a soil contaminant in areas which have been used for the production, storage or disposal of lead-acid batteries or lead products such as plates for dampcoursing and flashing, shot and bullets, and fishing sinkers. It can also arrive in the soil via certain types of paints and pigments, solder and pipes, and used motor oil. Lead arsenate was commonly used as a pesticide prior to the second world war, and can contribute to elevated levels of lead in the soil of old market garden sites.

❖ Cadmium is found as a contaminant in some types of superphosphate, and with repeated applications it can build up in the soil. It is also commonly found as a metal plating, and in batteries.

❖ PCBs, or polychlorinated biphenyls, were used until the mid-1970s in hundreds of commercial and industrial applications including electrical and hydraulic equipment, paints, plastics, rubber products, pigments and dyes, and carbonless copy paper.

Each of these contaminants, and the five main organochlorine pesticides, were found in at least one sample of eggs collected for the 1997 South Australian backyard egg survey (Hardy 1998).

IMPACTS

The use of organochlorine insecticides in the urban environment (both by market gardeners and by those attempting to eradicate Argentine Ants) had two main impacts on urban agriculture. Firstly, there is evidence pointing to a large decline in the insectivorous bird population in Perth following the commencement of the 1950s spraying programme (EPAWA 1988). This decline is likely to have been responsible for increases in other pest insects normally susceptible to predation by birds, and probably initiated a vicious cycle where more garden insecticides - including organochlorines - were used to counter the increased number of pests. Secondly, organochlorines accumulated in the eggs of fowls and other poultry.

In 1981, it was found that the average level of Dieldrin detected in eggs from fowlyards sprayed with Aldrin and Dieldrin was greater than 5 mg/kg - fifty times the regulation MRL (Maximum Residue Limit) of 0.1mg/kg for eggs (Dingle 1988). In Western Australia, a 1989 study of backyard eggs detected organochlorine

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In Australia, ADIs (Acceptable Daily Intakes) are set by the Therapeutic Goods Administration of the Commonwealth Department of Health and Family Services according to risks of adverse health effects over a lifetime of consumption. For example, the ADI for Dieldrin is 100 ng/kg body weight per day. For a 55kg person, the ADI is 0.0055 mg of Dieldrin per day. If that person eats two 50 g backyard eggs contaminated with Dieldrin at 0.07 mg/kg (below the MRL of 0.1mg/kg), they are getting 0.007 mg of Dieldrin, which is above the ADI for a person of that bodyweight.

levels that were ten times the relevant MRLs in 5% of samples tested (Hardy 1998). In an earlier test of ten egg samples from Perth backyards, seven exceeded the MRL, with one sample containing 80 times the MRL (Dingle 1988). The persistence of organochlorines in soil also means that they continue to accumulate in eggs long after spraying has ceased. In a South Australian study conducted in 1997, 10 years after DDT was deregistered, DDT was detected in 68% of backyard eggs (Hardy, 1998).

Even where residue levels are below the MRL, they can exceed the limits regarded as safe for health, represented by ADIs (Acceptable Daily Intakes). This is possible because the Maximum Residue Limit is based on levels of a residue that would be expected to appear in a food produced according to good agricultural practice. They are not direct health measures.

CONCLUSION

After several protests (one big one held in Perth in 1990), organochlorines were finally deregistered for all uses in Western Australia in 1995. However, since the conclusion of the "deregistration campaign", awareness of the potential for contamination of backyard eggs by organochlorine pesticides seems to have virtually disappeared. In 1998 and 1999, several of the people interviewed during the course of a study of urban agriculture in Perth and Melbourne indicated that one of the main reasons they grew their own food was because they wanted to be sure it was organic. As one interviewee put it: "you're pretty sure when you're growing your own food that it's going to be clean." Ironically, many people with backyard poultry did not realise that their eggs could in fact be contaminated with relatively high levels of organochlorine pesticides.

Organochlorine contamination of backyard eggs could affect a substantial number of people: comparable figures are not available for Perth, but a South Australian study in 1996 found that 23.6% of the population consumed eggs from backyard poultry (Langley et al. 1997). Where householders are aware of the potential risks, it is probable that some have been dissuaded from getting their eggs tested for organochlorine residues through lack of knowledge that such a service is available.

One could prohibit all food-production activities where the soil is, or could be, contaminated with organochlorine pesticides. However, a better way to address this issue (and similar problems of contamination) would comprise two steps. The first step involves awareness - making householders aware of the possible risks, through newspaper advertisements or letterbox drops. The second step involves actively helping householders to ensure that the food they produce is safe. This would entail firstly, free or subsidised testing of backyard eggs (or other produce); and secondly, advice and assistance with remediation of any contamination problem.

For example, poultry keepers with contaminated soil could be provided with plans for a deep-litter fowl shed, where birds are kept in an enclosed shelter on a layer of litter over a concrete floor. Presently, some local government authorities in Perth recommend (or require) such sheds for poultry, but as they generally fail to explain why such housing is appropriate, householders often see it as an unjustifiable expense or unreasonable Council requirement, and do not construct it.

Before issues of soil contamination in urban agriculture can be adequately addressed, there needs to be some acknowledgement on the part of state and local authorities that people are producing food in suburban areas, and are possibly doing so at risk to their health through no fault of their own. It should also be recognised that such food production, if carried out safely, can have economic and other benefits, and the response to problems of contamination should therefore look beyond prohibition. It is not being satisfactorily addressed in Perth.

NOTES

1 Unless stated otherwise, information on the proven or probable harmful effects of organochlorine chemicals is taken from International Chemical Safety Cards (ICSCs). The United States Environment Protection Agency position on organochlorines is derived from their Integrated Risk Information System (IRIS) database, available on-line at http://www.epa.gov/ngispgm3/iris/.

2 During the campaign, a total of 31,093.4 hectares were sprayed with 35,2 millions of litres of chemicals, at a cost of AU$ 4,963,230. The figure of 31,093.4 hectares overstates the total area that was sprayed, because areas that received multiple treatments were added to the total each time they were sprayed. As a result of the spraying programme, the extent of Argentine Ant infestation in Western Australia was reduced from around 17,000 ha in the late 1950s (mostly in Perth), to 1,458 ha in 1988, when the programme ceased. By 1991, the extent of infestation had again increased, to more than 3,000 ha.

Manila typifies the best and the worst of Asian cities. Affluent residential areas with functional sewerage and regular waste collection border squalid areas of cardboard shacks with no amenities. High-rise office and apartment buildings in the municipality of Makati stand in contrast to the squatter areas in Taguig, Muntinlupa, and Mandaluyong.The collapse of the Payatas garbage dump in August 2000 and the deaths of at least 220 squatters who lived at the dump site to scavenge discarded refuse are symptomatic of urban blight and poverty which threaten civility, governance and life itself.


Christian Ulrichs

Supporting Farmers towards Safe Year-round vegetables in Manila

This article focuses on part of the work of the project "Development of periurban vegetable production systems for sustainable year-round supplies to tropical Asian cities". The project aims to design, test and implement production systems for sustainable year-round supplies of vegetables to markets in Metro Manila - and by model verification, to other tropical Asian cities as well.

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Population growth in Manila with its attendant problems of waste disposal and competition for finite resources exacerbates environmental degradation and threatens fragile political systems with the potential for economic chaos. During the period 1990-1995, the population of Manila grew at a rate of 3.3% per year and was expected to reach 10.7 million in 1998. The population was 9.454 million or 1.998 million households in 1995, the last year for which data are published. Of those households, 432,450 or 21.6% were squatters living in 276 slum colonies located at about 70 sites in Metro Manila (17 municipalities).

THE PROBLEM OF FOOD SUPPLY IN MANILA

Manila residents, particularly the urban poor, rely on rice and meat as their principal sources of nutrition. Mean per capita food consumption was 828 g/day in 1993, with 293 g from cereals, and 267 g from meat, fish and milk (FNRI survey data from 1993 as cited by Ali and Porciuncula 1999). The poor generally eschew vegetables as they are often more expensive than meat. Mean vegetable consumption in Manila was 87 g/person/day. Based on these figures, simple extrapolation show that urban agriculture only produces about 0.5 % of the annual vegetable needs for Manila.

Per capita food consumption in Manila declined from 930 g/day in 1982 to 828 g/day in 1993. During the same period average per capita vegetable consumption declined from 120 to 87 g/day (Ali and Porciuncula 1999). Extrapolation of this trend suggests that consumption patterns by Manila residents, therefore, do not provide adequate nutrition or energy intake, particularly among the poor. Intake of calcium, iron, thiamine, riboflavin, niacin, vitamin C and particularly vitamin A was also deficient and deficiencies were most severe among residents who made PHP 10,000 per year or less (= USD 208 at PHP 48: USD 1). These nutrient deficiencies due to inadequate diet affect, human health, particularly the health of children and other vulnerable groups.

Some of these nutrient deficiencies can be improved through increased vegetable consumption. Several problems currently limit the year-round supply of vegetables including damage from insect pests and disease.

VEGETABLE FARMING IN PERIURBAN AREAS

In 1998-99, the periurban research team conducted an interview survey of 119 farmers working in two periurban areas of Manila. The survey was designed to characterise the social mores of farmers, the economic landscape affecting farming activities, and agricultural practices including pesticide use and attitudes to introduced technologies. The target area was 90 km from the centre of Manila in the municipality of San Leonardo, province Nueva Ecija, Central Luzon. Within San Leonardo we focused on two districts where vegetable farming is a year-round enterprise: 1) the current area of periurban farming activity (barangay Castellano); and 2) a neighbouring area (barangay Nieves) considered as a future site for technology transfer. In those barangays, farmers commonly follow a cropping sequence of three successive crops of pak-choi, followed by a single crop of radish and of onion, to be shipped to Manila markets. Although specific data per baran-

Yield was increased by 247 percent

gay are not available the province of Nueva Ecija supplies 13% of pak-choi, and 17% of all vegetables sold in Manila (Ali and Porciuncila 1999).
Findings of the survey suggest that farmers in San Leonardo possess the education and experience needed to assess the merits of new technologies offered. In contrast to conventional wisdom, gross income suggests that San Leonardo vegetable farmers are not poor and therefore have the means to invest in new technologies. Formal borrowing is minimal among vegetable farmers. Because only 3% of farmers own a vehicle to transport produce to markets and because informal borrowing is in the form of seed and fertiliser supplied by local assemblers, farmers are tied to a marketing system dictated by vegetable distributors.

KNOWLEDGE AND USE OF AGROCHEMICALS

All farmers interviewed reported to use chemicals to control pests and diseases. In fact, use of pesticides was seen as synonymous with pest management. The vast majority (85%) of farmers interviewed did not believe that insecticides were a panacea, but were necessary to curb pest attack. Only 20% of interviewees had knowledge of natural enemies, but all knew that pest infestations would increase if predators were killed by insecticides.

Safe handling and safe storage of pesticides are not common practices among farmers. Most (82%) apply pesticides while walking into the wind. Many (93%) wear clothing that might provide partial protection from spray drift (e.g. long pants, short or long-sleeved shirts), but only 3% wear masks and gloves. Clearly farmers are exposed to pesticide drift and that may explain why many respondents reported episodes of headache (77%), weakness (65%), dizziness (49%), vomiting (45%), and stomach pain (26%) following application. In spite of these startling figures, farmers persist in using unsafe practices. They know safe practices, yet chose to ignore them. Perhaps no greater contribution can be made other than to persuade farmers that their current practices place themselves and their families at risk. If we are to change pesticide-handling practices among farmers, we must first understand the reasons for their laissez-faire attitude.

Pests and disease problems of pak-choi are often intractable and yields are low in spite of frequent use of pesticides. Farmers therefore approach pak-choi production with a certain resignation that their best efforts at management might be thwarted by pests, whereas the same effort given to pest management in onion and radish generally leads to a successful harvest. Nevertheless, practices shown to improve pak-choi productivity and/or to decrease production expenses should be marketable among farmers in San Leonardo.

The pesticide quantities can be reduced

ATTITUDES TO INTEGRATED PEST MANAGEMENT

Farmers' opinions of new technologies including IPM practices, raised beds, rain shelters, and organic fertiliser for pak-choi management changed between years 1 and 2 of the periurban project as a result of on-farm activities of the project in San Leonardo. Initially perceived as having "low sustainability," farmers at the end of year 2 rated those practices as having "moderate sustainability." Here, sustainability refers to the farmers' perception of their capacity to dedicate resources to implement new practices. About 90% of farmers interviewed perceived IPM to require moderate labour inputs and time, yet 82% consider implementation of IPM practices to be complicated and therefore not adaptable to their enterprise. Even farmer co-operators, those intimately associated with IPM activities, want "a silver bullet" (a potent pesticide) to solve pest problems. They do not yet grasp that management requires knowledge of the interrelationships of pest intensity, crop damage, and economic environment. Farmer perception makes it imperative that training documents and training exercises address these interrelationships and therefore the complexity of IPM, in a language and form understandable by farmers. The potential "pay-off" from implementation of IPM practices among farmers would lead to reduced pesticide use and therefore reduced pesticide residue on farm produce, and to decreased exposure.

There is a need to persuade farmers that by monitoring pests prior to pesticide application, by using screen structures to reduce insect damage, and by reducing fertiliser cost, expenses will be reduced and income increased, thereby reducing the capital/output ratio. Economic analysis of standard farmer practice for pak-choi in contrast to use of a technology package showed that yield was increased by 247% and the cost differential was 103%.

The project has been able to demonstrate among farmers that their practice of pest management in leafy vegetables can be improved. That is, the number of pesticide treatments they make and the pesticide quantities they apply can be reduced by first assessing pest intensity and then applying pesticides only if numbers reach action thresholds specific to each pest and disease. Participating farmers are given a copy of a large poster with photographs of insect pests and disease symptoms to facilitate pest identification and to indicate the timing for pest assessments relative to date of planting and crop phenology.
The poster is used in conjunction with a booklet in which farmers record pest numbers. By use of the poster and the action book, pesticide use is linked to actual not imagined, pest intensities.
Nevertheless, there are occasions when numbers of insect pests overwhelm any management strategy based on intervention with registered pesticides. Experience has demonstrated that farmers and researchers fail to prevent crop loss when rate of pest development exceeds the capacity of pesticides to maintain populations below a damage threshold.

Increased use of IPM has the potential to improve the health of farmers by reducing the risks of pesticide exposure.
Another health benefit of the Philippine Periurban Vegetable Project is improved food security by implementing production systems for sustainable year-round supplies of vegetables to markets in Metro Manila.

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Zoonoses of Dairy Cattle

with Reference to Africa

Zoonoses are infections naturally transmitted between vertebrate animals and humans, either directly or indirectly through the consumption of contaminated foods. Traditional zoonotic diseases for which effective control measures and cures are available in affluent countries, are still a cause of morbidity and mortality in humans and animals in developing countries (Wastling et al. 1999, Cosivi et al. 1995). Increasing urbanisation, the growth of livestock production in close proximity to humans, the rising rate of HIV, inadequate hygienic practices, and cultural customs and beliefs exacerbate the transmission, persistence and impact of zoonotic diseases in these regions.

C. Furedy

Pigs scavenging from garbage on street

In order to satisfy the constantly increasing demand for milk and milk products in sub-Saharan Africa, dairy production systems in urban and periurban regions are a dynamic and fast-growing sector. Thus, there is an initiative to increase local milk production through the importation of exotic breeds and intensification of livestock production. These developments increase the potential risk of transmission of Bovine Tuberculosis and Brucellosis to humans. This is especially risky

Information is scarce

since approximately 90% of the total volume of milk produced in sub-Saharan Africa is consumed fresh or soured and only a small proportion follows official marketing channels (Cosivi et al. 1995)

The control of zoonotic diseases in West Africa is hampered by poor infrastructures and lack of resources across the different countries. Available diagnostic and prevalence data is often based on small-scale surveys, abattoir surveys and hospital records and does not represent a real epidemiological situation. Inadequate disease-reporting systems and insufficient collaboration and communication between human health and veterinary services further compound the problem (Wastling 1999). Reports often focus on aspects of public health or animals, but seldom tackle both. This deficiency in baseline epidemiological data on the occurrence of zoonotic diseases in humans and animals poses a challenge in identifying the diseases of primary importance to public health in West African countries.

This paper focuses on those diseases that are relevant to humans and livestock. Bovine Tuberculosis and Brucellosis, long-standing public health concerns, are the most widely reported pathogenic bacteria in African dairy cattle.

Tuberculosis and Brucellosis are classical direct zoonoses, both potentially transmitted through contact with ruminants and consumption of improperly treated dairy products. Whereas human infection by these organisms was more commonly a rural problem in farming households and livestock keepers, the distribution and epidemiology of these infections in urban and periurban populations may indeed be changing as urbanisation progresses. The intensification of milk production without adequate measures of processing and the use of inofficial marketing channels increase the risk of transmission. Tuberculosis (*Myco-*

ZOONOTIC DISEASES CLASSIFIED

❖ **Direct:** where diseases are transmitted to a susceptible vertebrate host by direct contact or vector. The distinguishing characteristic of this group is that only one vertebrate host is necessary to maintain the agent. Methods of transmission include direct physical contact, handling of tissues or infective tissue fluids, inhalation of droplet nuclei and ingestion of infected secretions or tissues.

❖ **Cyclozoonoses:** this group requires more than one vertebrate host (but no invertebrate host) to complete the agent's life cycle. An example of this group is *Taenia solium* (a parasite of pigs that results in the development of intestinal tapeworms in humans).

❖ **Metazoonoses** require a vertebrate and an invertebrate host for perpetuation and are a group with complex "webs of causation".

❖ **Saprozoonoses** require a non-animal site, usually soil or water, to develop and/or survive.

(Martin et al. 1987)

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bacterium tuberculosis) is still the single leading cause of human morbidity and mortality due to an infectious agent. Approximately 10% of people infected by the bacteria will progress to fulminant disease at some point during their lives. In immune-suppressed and HIV-positive individuals, this figure rises to 40%. In sub-Saharan Africa, 2 million new cases arise every year and 32% of deaths in HIV-infected individuals is due to Tuberculosis (TB), making it the largest attributable cause of death in this group. As a result of the HIV epidemic, the crude incidence rate of TB had increased in this region from 191 cases per 100,000 in 1990, to more than 250 cases by 1997 in some African countries (Cosivi et al. 1998, WHO 1999).

TUBERCULOSIS

Mycobacterium tuberculosis and *Mycobacterium bovis* are the bacterial agents of tuberculosis in humans and cattle, and infection can result in a chronic disease. *M. bovis* is infectious to humans and can pose a serious zoonotic risk (Gallagher and Jenkins 1998).


P. Muchaal

Herd in Bamenda Highlands in Cameroon

Impact on public health is still unclear

Although the great majority of human TB infections are due to *M. tuberculosis*, largely undetermined portions of the total result from infection by *M. bovis*. Information on human disease due to *M. bovis* is scarce. Where African data have been available, approximately 1-5% of positive cultures from human cases have proved to be *M. bovis* (Daborn et al. 1997, Elasabban et al. 1992, Idigbe et al. 1995). The relatively low isolation rate of *M. bovis* from human TB cases in developing countries, including Africa, may be partly due to the extensive use of microscopy for confirmation of suspected cases, a technique that does not permit differentiation between species of mycobacteria.

Epidemiology

In the case of bovine TB, the infected animal is the main source of infection. Transmission can also occur through contact of infected environmental sources (soil, water). Organisms are excreted in the exhaled air, sputum, faeces, milk, urine, vaginal and uterine discharges and discharges from peripheral lymph nodes. Both *M. bovis* and *M. tuberculosis* are manifested in a primary and a post-primary form (this is dissemination to secondary sites in the body after initial infection), and the site of disease reflects the route of infection.

M. tuberculosis is usually inhaled and leads to primary lesions on the lungs, with occasional extra-pulmonary lesions. On the other hand, *M. bovis* is usually acquired through consumption of contaminated milk. This is the primary means of transmission to sucklings/young and to humans. However, farm workers are more prone to inhalation of infective droplets from diseased cattle (Blood et al. 1984).

In contrast to human infection, the primary lesions in cattle rarely heal spontaneously, but tend to disseminate locally through the natural cavities. In humans, *M. bovis* is less virulent than *M. tuberculosis* and is, as a result, less likely to proceed to post-primary infections of disease.

Housing and zero-grazing predispose the animals to the disease. The highest incidence of bovine TB is generally observed where intensive dairy production is most common, notably in the milk sheds of larger cities (Cosivi et al. 1998) where the bulk of the milk is destined for market in urban regions.

Bovine TB in West Africa

Reports of bovine TB vary among the West African nations. The methods of collecting and presenting information are haphazard and random. One cannot draw, with confidence, any conclusions about the prevalence or incidence of each strain in either humans or animals, nor the route of transmission between the two. Although the risk of transmission is real, there is no published evidence establishing an epidemiological association between tuberculosis in cows and bovine tuberculosis in humans in West Africa. However, due to the limitations on data compilation in the region, the figures presented here are undoubtedly a conservative estimate of the prevalence and distribution of the disease amongst the West African nations. Furthermore, TB acquired through the consumption of contaminated raw milk resulting in extra-pulmonary infection may be less likely to be detected or diagnosed than pulmonary disease.

BRUCELLOSIS

Brucellosis is a bacterial zoonosis with worldwide distribution and remains a major source of disease in humans and domesticated animals. For humans, the disease can cause undulant fever. Animal production is primarily affected by the decreased milk production in dairy cows. Three of the six identified Brucella species are zoonotic, notably *Brucella abortus, Brucella melitensis*, and *Brucella suis*, and are transmitted directly or indirectly to humans from cattle, sheep and goats, and pigs respectively.

Epidemiology

The three species of Brucella of concern to public health are of bovine, ovine-caprine and swine origin. Although bovine Brucellosis is the most widespread form, *Brucella melitensis* is by far the most important clinically apparent and pathogenic disease in humans. Sheep, goats and their products remain the main source of infection, although recently *B. melitensis* has also begun to emerge as a disease of cattle (Corbel 1997).

Humans become infected by ingestion, direct contact, inhalation, or accidental inoculation by penetration through mucous membranes of the eyes, throat and lungs and/or intestinal mucosa, or through skin abrasion or injury. Milk, cream, and fresh cheese are the main source of human Brucellosis. Excretion in milk may attain its highest level at the beginning of lactation and then decline to a few bacteria, but may persist during successive lactation periods. During cheese production, the number of bacteria decline with the acidification produced by the lactic bacteria. Therefore, survival depends on the type of cheese and the ripening involved. *Brucella* bacteria are also destroyed by pasteurisation.

Excretion from the genital tract from an abortion or normal birth, which continues for some weeks, is the second most important source of infection for humans. For animals within the same herd, this is the major source of infection. Infection can occur by direct contact or indirect transmission through contaminated items in the environment. *Brucella* survives in soil, water and manure depending on the material, temperature and sun exposure. Bacteria can also contaminate drinking water. Airborne dust or droplets may cause transmission, particularly so when high-pressure jets or water are used during the washing of premises. Meat products, mainly spleen, liver, genital organs, lymph nodes and meat with remnants of lymphatic tissue constitute an important source of human and animal infection.

Brucellosis in West Africa

Brucellosis is regarded as a major problem among ruminants in Africa (Wastling et al. 1999), yet the true incidence of human brucellosis is unknown and there is scant evidence of the impact of this disease on public health in West Africa. Clinical signs of Brucellosis in humans can be misleading with cases manifesting gastrointestinal, dermal, neurologic and respiratory problems. Brucellosis symptoms can mimic those of other illnesses (such as malaria) and cases may therefore remain undetected or misdiagnosed.

According to the Office of International Epizootics (OIE 1999) in Cameroon, Mali and the Ivory Coast were the only West African countries cited as either reporting or suspecting the presence of bovine Brucella. While some areas may have a high incidence of acute infections, the low incidence reported in other known Brucellosis endemic areas might reflect low levels of surveillance and reporting.

Furthermore, factors such as livestock species raised, methods of food preparation, heat treatment of dairy products, and direct contact with animals also influence risks to the human population. In animals, the presence and transmission of Brucella is moderated by an interrelationship of factors including climate, types of production systems (nomadic/transhumance or sedentary; extensive vs. intensive), herd size, livestock breeds and the age of the animal (Blood 1984, Plommet et al. 1998).

Most studies of Brucellosis in West Africa focus either on animals or humans. Only one study (Gidel 1974) investigated the prevalence in both livestock and people. Results indicated that the prevalence of brucellosis in all ruminant species was highest in the woody savannah and decreased in the savannah and dry zones.

Akapo (1987) conducted a serological study of animal Brucellosis in five West African countries. The prevalence of the disease was similar for Benin, Cameroon, and Burkina Faso (10.4-12.3%), but was relatively higher in Niger (30.5%) and Togo (41%). In general, there appeared to be greater abundance of infected animals in intensive production systems at the periphery of urban centres and in urban areas than in the more traditional rural systems.

CONCLUSIONS

Traditional zoonoses are present in some African environments. However, the risks of transmission and impact on public health are still unclear.

Education and improved sanitation could greatly reduce the incidence of some of these diseases. Proper hygienic practices and good husbandry in many situations can go a long way in ameliorating the transmission of zoonotic diseases. Control strategies in livestock need to be adapted to local conditions.

In the absence of sufficient veterinary supervision, the intensification of dairy production may be the single most important determinant in increasing the prevalence of bovine TB in humans and animals. Milk plays a key role in the transmission of TB and brucellosis and therefore may be the most practical level for intervention. Pasteurisation or other adapted techniques should be evaluated and implemented concurrent with the establishment of a dairy producing system. In the absence of the infrastructure and technologies for the commercialisation of safe milk, education is the most effective tool for prevention of transmission to humans. Incentives to produce TB-free milk appear to be successful. In Ghana, farmers are offered a premium price for their milk if it is free of *M. bovis* when presented for sale (Wastling et al. 1999).

Systemic vaccination for Brucellosis (and to a lesser extent tuberculosis) is recommended in the absence of an adequate surveillance system and where the prevalence is greater than 5%. Vaccination increases individual resistance to systemic infection, and in infected animals decreases the probability of placental infection, abortion and massive shedding of infectious organisms. These combined facts interact at the herd level, to confer good overall protection, provided that all individual animals are properly vaccinated.

Carefully planned epidemiological studies in (peri)urban regions, in combination with appropriate diagnostic assessment need to be carried out to determine the risks of exposure and acquisition of diseases. These investigations also assist in determining whether transmission is occurring from human to human or animal to human, thereby identifying control points for the various diseases.

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Public Health Issues
of Wastewater-fed Aquaculture

Farming fish in ponds fertilised with urban wastewater or sewage is not widespread although it does benefit millions of people, particularly in China, India and Vietnam. It provides food and employment, particularly for the poor, and more general environmental benefits such as low-cost wastewater treatment, stormwater drainage and provision of green areas or "lungs" which improve the health and well-being of urban residents.

Peter Edwards

Harvesting fish from a wastewater-fed pond in Calcutta.

It is important to note that most wastewater-fed aquaculture systems, although often large and covering areas of tens to hundreds of hectares or more, are traditional in the sense that they have been developed mainly by farmers and local communities. Pond complexes have been developed in the past in water-logged, low-lying areas such as lakes, marshes and wetlands mainly in periurban areas where settlement and alternative uses of land have been impeded. The availability of large volumes of nutrient-rich wastewater pouring out of the city at little to no cost, led to its re-use by farmers as a fertiliser for fish culture. They gave scant attention to either waste treatment or to public health.

Fish is mainly purchased by less well-off consumers

First impressions invariably are that fish farmed in such systems are not safe to eat because of likely infection from disease-causing organisms contained in domestic wastewater. In contrast, anecdotal evidence and a growing body of scientific evidence indicate that such fish pose relatively low risks to public health -even though wastewater is increasingly contaminated with toxic-laden industrial wastewater- contributing in particular to increased welfare of the urban and periurban poor.

Public health aspects of wastewater-fed aquaculture are discussed here with reference to Calcutta. Calcutta is the largest and best documented system in the world, but in contrast to most other areas, the benefits derived from these experiences are leading to the development of newly-designed systems elsewhere in the Calcutta Metropolitan Area (CMA) and West Bengal.

THE CALCUTTA SYSTEM

The wastewater-fed fish ponds cover about 2,500 ha and are located in a government-designated recycling region for the city which also includes cultivation of vegetables on wastewater, garbage and rice in paddy fields irrigated with fish pond effluent (Ghosh 1990). Since about 1930, when a landowner discovered how to farm fish by releasing wastewater by gravity from the sewage channel leading to the estuary, the area of fish ponds expanded rapidly to a peak of about 8,000 ha in the 1950s, after which it declined markedly to about 2,000 ha today, due to urban expansion. Major cultured species are rohu, silver carp and tilapia, which produce relatively high yields of 3-8 tonnes/ha/year because of multiple stocking and harvesting of fish in fertile pond water. Currently, the wastewater-fed ponds provide employment for about 17,000 poor fishermen and produce 20 tonnes of fish daily for urban and periurban markets in Calcutta. Fish is mainly purchased by less well-off consumers.

Calcutta is located in West Bengal where a cultural preference exists for fish as compared to meat. Large- and small-sized fish appear to be purchased by different socio-economic groups of city dwellers, by the better-off and poorer consumers, respectively (Morrice et al. 1998). Moreover, larger carps, which dominate freshwater fish on the market, are mainly imported on ice from other states in the country by rail, with most of the smaller-sized fish raised locally in wastewater-fed ponds. Small fish (< 250 g) dominate sales in city retail markets. Producers either transport fish to city markets themselves, or sell them to poor traders who transport small fish in

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open bowls and get higher prices if the fish remain alive.

In the Calcutta system as well as in most other wastewater-fed pond systems, the wastewater has already undergone partial treatment as it takes several hours to flow from city outfalls along open channels to the ponds. As it flows into the ponds, it is rapidly diluted with pond water. Nutrients in the wastewater stimulate aquatic food webs comprising phytoplankton and zooplankton in the water column and organisms such as midge larvae and tubifex worms in the pond sediments, which provide natural food for fish.

The colour of well-managed, wastewater-fed fish ponds is green due to the dominance of phytoplankton in the water. Besides providing the main source of food for the three major filter-feeding species of fish farmed in the ponds, the phytoplankton have a major influence on the quality of the water in the ponds. Intense photosynthesis by phytoplankton in "green water" ponds raises the pH during the daylight hours, which helps to remove both microbial and chemical contaminants that would otherwise threaten public health.

HEALTH RISKS

The major health risks in wastewater-fed aquaculture are both biological hazards from potential disease-causing organisms in human excreta in domestic wastewater, and chemical hazards from industrial effluents (see table 1). In Calcutta, there is an unregulated discharge of effluents from thousands of small-scale factories; also 600 tanneries discharge 150 kg of the heavy metal chromium daily into an urban wastewater channel that drains into fish ponds.

Biological hazards

Research has shown that there is a rapid dying-off of enteric bacteria and viruses in well-managed, wastewater-fed fish ponds (WHO 1999). This is due in part to phytoplankton raising the pH in "green water" ponds. Despite this, pathogenic enterobacteria (from the human digestive tract) have been occasionally found in fish guts although not in fish muscle. Consumption of wastewater-fed fish would thus not be a hazard to consumer health if they are gutted, washed and cooked well. Risk from enteric viral disease is considered to be lower than for bacterial diseases based on epidemiological evidence (WHO 1999).

Food-borne trematodes (Chinese liver fluke, *Clonorchis sinensis;* the live fluke, *Opisthorchis viverrini)* cause diseases in some parts of the world. The cause of infection is ingestion of raw, poorly-cooked or minimally-processed fish that contains viable trematode cysts. Another trematode, *Schistosoma* spp, which causes Schistosomiasis or Bilharziasis, infects humans by larvae penetrating the skin and is thus a potential occupational disease for pond workers.

Unlike microbes, trematode worms are distributed locally. None of the major species occurs in Calcutta: *Clonorchis sinensis* is endemic to China and N. Vietnam; *Opisthorchis viverrini* to Laos and Thailand; and *Schistosoma* spp. mainly to parts of Africa and Latin America. The relative contributions of aquaculture and wild fish to food-borne trematode disease are unknown.

Consumers face a greater (although still relatively low) risk to their health than producers or fish farm workers. With the exception of Bilharziasis, most diseases occur through consumption of contaminated fish. Bilharziasis can be controlled by integrated approaches involving health education, snail control and selective population chemotherapy in areas where it occurs (McCullough 1990).

Chemical hazards

Urban wastewater is likely to contain a high concentration of chemicals such as heavy metals and chlorinated hydrocarbons if it is mixed with industrial wastewater. The chemistry and fates of such chemicals in the aquatic environment are complex. However, concentrations of heavy metals in fish do not exceed regulatory or recommended levels, even when the fish have been harvested from water with high metal concentrations (WHO 1999, Eisler 2000). Heavy metals are precipitated as insoluble sulphides or hydrated oxides under anaerobic (or oxygen-free) conditions as occur in raw sewage, and levels are reduced further in the alkaline water of wastewater-fed ponds as the solubility of metals decreases with increasing pH.
In addition, metals also tend to precipitate into anaerobic pond sediments rich in organic compounds. Furthermore, although fish absorb metals through the gills and from food in the gut, they regulate the concentrations of inorganic metal compounds in muscle tissue. An exception is mercury, which is poorly regulated by fish in its organic form, methyl mercury. However, this is primarily a concern in older and larger carnivorous fish, which

Table 1: Relative importance of various health risks in wastewater-fed aquaculture

Health risk	Relative importance: low risk	higher risk
Biological hazards		
Microbes		
Bacteria	●	
Viruses	●	
Trematode worms		
Clonorchis		●[1]
Opisthorchis	●[1]	
Schistosoma		●[1]
Chemical hazards		
Heavy metals	●	
Chlorinated hydrocarbons		●

[1] local importance

Peter Edwards

Poor traders transporting fish from wastewater-fed ponds to market in Calcutta.

Several new wastewater-fed aquaculture systems have recently been constructed in India. These include pre-treatment since wastewater re-use has been accepted by local governments as being superior to conventional mechanical treatment plants in terms of cost, benefit and reliability (Ghosh 1998). Three systems have been constructed within the CMA under the Ganga Action Plan to reduce the adverse environmental impact of municipal wastewater on the river Ganges, and another system has been constructed in Kalyani township in West Bengal (Jana, 1998). A system at Mudialy in the CMA that receives a high amount of industrial wastewater has recently been upgraded also by introducing anaerobic ponds and water hyacinth-filled canals. Furthermore, an improved fish pond design has been published for India (Mara 1997) based on a concept of maximum production of fish safe for human consumption from wastewater (Mara et al. 1993).

are at the end of long food webs because of bioaccumulation, rather than in fish cultured in wastewater-fed ponds (which feed low down in the food web and are harvested when relatively small and young).

Although they were well within recommended safety levels, residues of three heavy metals (cadmium, chromium and lead) in three commonly raised species (the Indian major carps *mrigal* and *rohu*; and tilapia) were much higher in fish from wastewater-fed ponds purchased at seven markets in the CMA, than from a rural market (Biswas & Santa 2000). City vegetables also had higher heavy metal content than those from the rural market. Although the risk of unsafe levels of heavy metals in fish raised in wastewater-fed ponds is very low, there is a need to consider the total daily intake of metals from all sources. This is especially so if there is daily consumption of fish and vegetables contaminated with heavy metals, which are staple foods in Calcutta.

Fish raised in contaminated water show only low tissue levels of organic pollutants such as chlorinated hydrocarbons. However, it is recommended that these should be considered as a risk because of the limited amount of available data (WHO 1999).

TOWARDS INCREASED PUBLIC HEALTH

Although the risk to public health from wastewater-fed aquaculture appears to be low, safety may be further improved by various means (Edwards 2001):

Introduction of more realistic guidelines
The current, tentative guidelines of WHO (1989) are "unduly restrictive" and have constrained the development of more widespread wastewater-fed aquaculture. The high recommended degree of treatment of wastewater to 1 x 10^3 faecal coliforms / 100 ml before it is introduced into a fish pond may require a series of ponds, which leads to minimal fish production because of nutrient removal before the wastewater stream enters the fish pond. The WHO recognised this and called for epidemiological guidelines based on actual risk rather than the current guidelines based on potential risk (see page 25). The WHO (1989) also recommended that guidelines, which are currently being revised, should follow a more integrated approach involving control of wastewater application, exposure control and promotion of hygiene as well as wastewater treatment.

Wastewater should never be used raw
Primary treatment in particular is required, with a minimum of 8-10 days to remove trematode worms which are considered to be one of the major threats to public health (WHO 1989), at least in some areas. Primary treatment would also increase the removal of toxic chemicals because it has anaerobic conditions.

Reduction of the level of industrial effluents in urban wastewater
This may be difficult to achieve in rapidly industrialising developing countries. Even if fish do not contain hazardous levels of toxic chemicals, it may prove increasingly difficult to market fish contaminated with industrial wastewater as they are tainted (smell and taste) with petroleum and phenolic compounds as has happened in China (Edwards 2000).

Control of wastewater application
This should be introduced by suspension of wastewater loading for 2 weeks prior to fish harvest and holding fish for a few hours to facilitate the evacuation of their gut contents.

Production of good hygiene
This includes handling and processing of wastewater-fed fish, including gutting, washing, avoidance of cross-contamination with other food in the kitchen, and cooking or processing well

Hazard Analysis and Critical Control Point (HACCP)
Introduction of the principles of the HACCP system could be a general strategy to control specific hazards, thereby reducing the need for costly routine end-product testing (Reilly & Käferstein 1997). As there is no conclusive evidence for passive transfer of pathogenic bacteria and viruses from wastewater-fed fish to humans, and contamination of fish with toxic chemicals is usually within regulatory limits, the major critical point may be to achieve the total elimination of helminth or worm eggs. This is feasible within the recommended guidelines for the minimal treatment of wastewater prior to its use in aquaculture (Mara et al. 1993, Mara 1997) although it would be superfluous for Calcutta and West Bengal.

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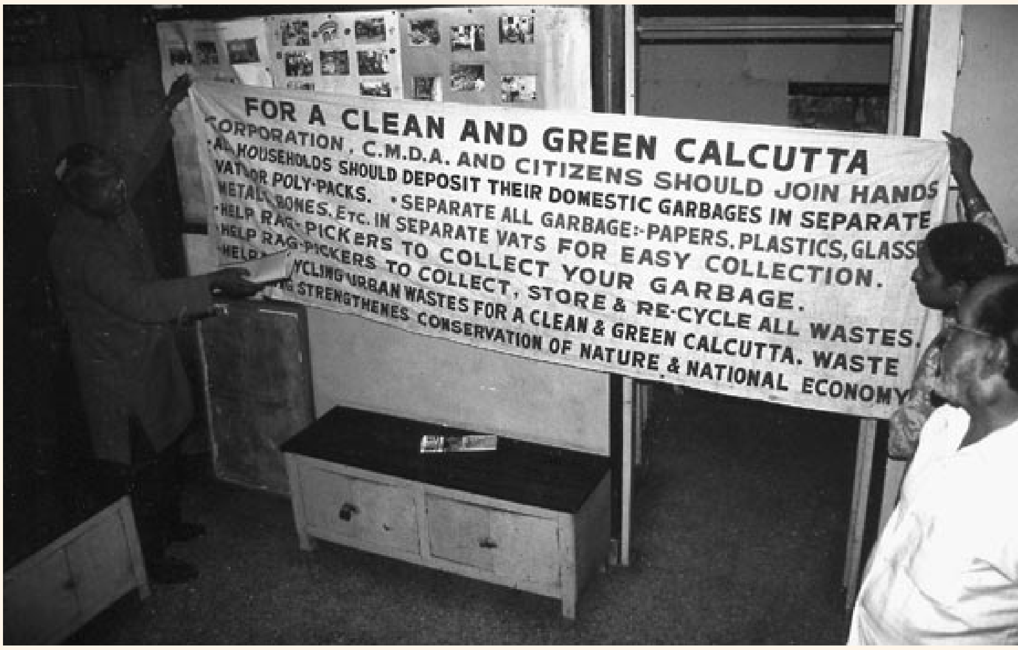
Reducing Health Risks

of Urban Organic Solid Waste Use

Whereas health concerns received little attention at the beginning of the thrust to promote urban and periurban agriculture in the past five years, progress has been made in articulating the health issues in developing countries. This paper comments further on one aspect related to the issue of health and urban agriculture: the risks of urban organic solid waste re-use.[1] The focus is the relation of health risk management to informal or community-based practices, which are seen as a major challenge for agriculture in the city. Because the capacity of governments to intervene is currently limited, gradual progress in self-regulation or self-limitation of risks is necessary. International projects and experts can assist in developing appropriate standards, research and practical measures.



C. Furedy

A CBO in Calcutta (United Bustee Development Association) promotes source separation of household waste

Obtaining and processing urban organic solid waste for these different purposes involves many actors (see for details Furedy, Maclaren & Whitney 1999). Main uses of urban organic solid waste in cities of developing countries are: the application of untreated organic material from mixed municipal wastes directly to soils (e.g. Hyderabad); cultivation on old garbage dumps (e.g. Calcutta, see: Furedy & Chowdhury 1996); the feeding of animals with wastes and waste-derived feed (containing slaughterhouse wastes - an ubiquitous practice, e.g. in Hanoi, see Le 1995); and the composting of organic material in mechanised and small neighbourhood plants (e.g. in Accra, see Asomani-Boateng & Haight 1999).

The principal problems associated with these activities are:

- survival of pathogenic organisms in residues;
- zoonoses associated with animal wastes;
- increase of disease vectors;
- respiratory problems from dust and gases;
- injuries from sharp fragments; and
- contamination of crops from heavy metal take-up and agro-chemical residues via wastes and their leachates.

The concern is not exclusively with human health, as livestock are precious, and sometimes irreplaceable, resources for low-income farmers.

Most of the activities associated with the re-use of organic wastes are informal or semi-formal. The following chart indicates some of the main practices of urban organic waste re-use. The diversity of activities and actors, and their informal contexts, makes the management of health risks a seemingly overwhelming task.

REDUCTION IN HEALTH RISKS: INTERIM MEASURES

Current limits on regulation

A range of prevention and control measures could potentially ameliorate the diverse risks posed by using urban organic solid waste for food production (see Furedy & Chowdhury 1996). In the developing countries, however, most urban organic waste processing and re-use in urban agriculture is informal or semi-formal, whereas most of the proposed measures entail relatively sophisticated official interventions, new technologies, infrastructure development and re-design of waste management, cultivation and animal-rearing systems. Since there is little immediate prospect of effective intervention in the many informal

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activities, we must take what comfort we can from positive trends of 'self-help' in this field, and seek the easiest avenues for introducing information and low-cost technology at the urban and community level.

Self-regulation
There is evidence to suggest that when municipal solid wastes become seriously contaminated with non-decomposable materials and biomedical wastes, the practice of applying solid wastes to farms declines. Reports from periurban farmers who previously applied solid wastes to their fields around cities like Hyderabad, Delhi and Hubli-Dharwad in India indicate that many have discontinued the practice because they cannot attract sufficient agricultural labour, but also because their draft animals are too often injured by glass and syringes (Nunan 2000).

As levels of education rise in the urban population in general, there is also a better understanding of problems of waste management: concepts of waste reduction, separation at source of organics, and composting are no longer unfamiliar and there is more willingness to pay fees for solid waste management (Lardinois & Furedy 1999). It is rare to find a city now that does not have environmental NGOs with some interest in pollution and waste management, and such groups are well positioned to improve public awareness.

Sorting bone wastes in informal fertiliser plant, Kathmandu

C. Furedy

For instance, in the 1960s and 1970s, most of the pickers on Calcutta's municipal garbage dump worked barefooted, while now all, except perhaps young children, wear rubber or plastic sandals (even if picked from the garbage). More waste pickers are seen to cover their noses and mouths with scarves, and to try to protect their hands from cuts.
Nevertheless, many of the serious risks cannot be 'seen' by those handling wastes. Further, people are slow to change their behaviours when their livelihood is at stake and public officials are also concerned about employment. Improving informal work is a slow process of education coupled with providing feasible alternatives.

Setting standards
Suitable standards for assessing health risks are required. International collaboration is required to reaching these standards. One area requiring attention is composting, in particular waste-derived compost. There is considerable interest in promoting composting of urban organics on a 'decentralised' or small scale at community sites. Many international and bilateral agencies have funded pilot projects in urban composting (see Hoornweg et al. 1999).

Farmers stop using contaminated solid wastes

A weakness is that few if any of the current projects pay attention to public health risks. The rationales of the projects assume that small-scale composting, and composting in general, will be beneficial to public health. Many questions remain unanswered, though. For instance, whether community-based composting increases rodent populations, and sites for vector breeding (although there are anecdotal reports that it may). In theory, well-managed composting should not have these effects, but small composting projects are rarely so orderly.

Most small-scale composting projects do not test their products (or the liquid wastes) for contamination, but if they did, the testing undertaken would likely be limited to tests of heavy metals such as arsenic, cadmium, lead, etc. This is because most tests of compost are derived from Northern standards (and even these vary remarkably, see Blaensdorf & Hoornweg 1997). The inputs for low-tech composting in urban neighbourhoods are more varied than the green wastes composted in most Northern cities, since source separation is not consistently practised. Furthermore, the temperature levels and maturation times necessary to destroy pathogens may not be consistently maintained in small NGO projects. It will be very difficult to monitor the products of scattered community composting undertakings.

Even in Northern countries, compost standards are being questioned. The Composting Association in the United Kingdom is working towards a voluntary standard for the UK that specifies minimum criteria for "potentially toxic elements, pathogenic micro-organisms and physical contaminants"[3]. Developing countries that are proposing to set compost standards at all, are for the most part adopting the older heavy-metals-based approach. Some scientists believe it is impractical to develop pathogen standards for compost in developing countries, and that the only feasible approach is to control the composting process (Hoornweg et al. 1999). Even if pathogenic standards cannot be applied, however, further work should be done to develop baseline indicators.

A big question mark hangs over "vermi-composting" because this compost is produced at lower temperatures than in the aerobic process. The recommendations in Europe, that the organic material be digested anaerobically before being put in worm beds, is not done in developing countries. In the municipal compost plant in Buenos Aires, however, worms are used to 'mature' compost, a process that adds two months to the production cycle but which should ensure the safety of the compost (Lardinois & Furedy 1999).

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Some general guidelines for safety standards will only be the beginning: local standards must be devised, to take into account the nature of soils, cultivation methods, the crops grown and local culinary habits.[4]

Low-cost options

In the sectors of sanitation and housing, the great strides in service delivery came with more attention to low-cost options in the 1980s. The same approach can be applied in waste management related to urban and periurban agriculture. The subject of low-cost and small-scale amelioration of risk has not been much discussed and there are few examples of actual interventions. Some first steps are suggested here.

An important area for development is the very small-scale wastewater treatment systems able to achieve a standard suitable for irrigating urban plots. In amending agricultural practices, tried and tested procedures for control measures (for example, in crop selection) can be adapted from the work in small-scale wastewater irrigation projects.

Cities that have created sanitary facilities and health services to waste pickers, can extend the same protections to workers handling organic wastes. Community-based projects should ensure facilities and protective clothing, as well as health risk advice, for all staff. Many of the problems of composting units could be reduced if source separated organics could be obtained.

With regard to infrastructure, since the replacement of most garbage dumps with sanitary landfills is not possible, the creation of separate cells at dump sites to receive biomedical and industrial wastes should be a priority wherever 'mining' for organics and waste picking is present (see Nunan 2000). In community-based composting projects, more attention has to be given to the collection and disposal of leachates from decomposition.

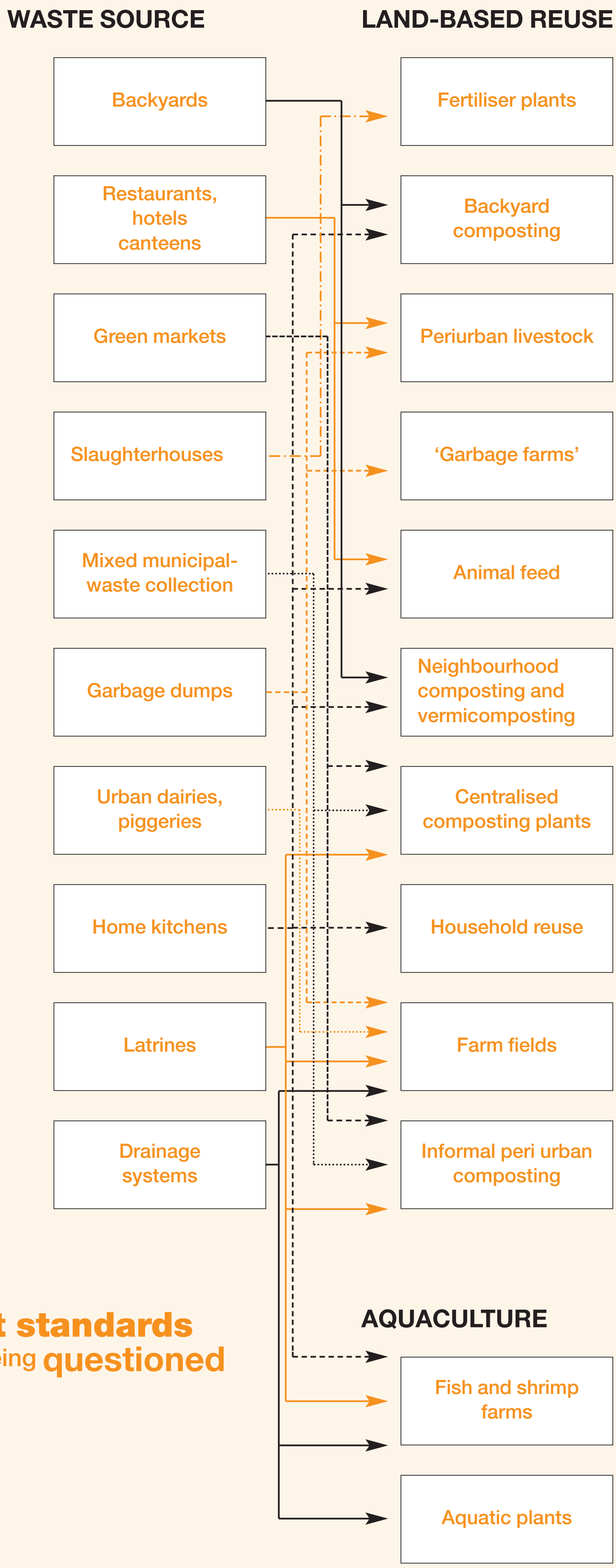
Control and monitoring of urban animals, their products and their slaughtering is a gargantuan task for many cities. Much better education of the public and the keepers of animals can pave the way for relocation, regulation and inspection.

CONCLUSION

Realistically, it cannot be expected that a great deal of research will be done on the specific health risks associated with many informal activities in urban food production. Nevertheless, the range of possible risks cannot be ignored, especially when international agencies are strongly promoting urban agriculture. What is needed is an approach that tries to balance risks and benefits. Development itself brings many improvements in public health and greater awareness among the public. In attempting to reduce risks while enhancing food production, cities will have to rely at first on available low-cost options for soil, water, and waste management. International and bilateral projects bear a special responsibility to foster awareness among the public and urban officials; such projects are the easiest way to convey practical understanding at the local level. At the international level, experts can contribute to progress through discussion of appropriate standards for soils, compost and waste management.

Compost standards are being questioned

Figure 1: Urban organic waste reuse in developing countries.



Source: Adapted from Furedy, Maclaren and Whitney 1999

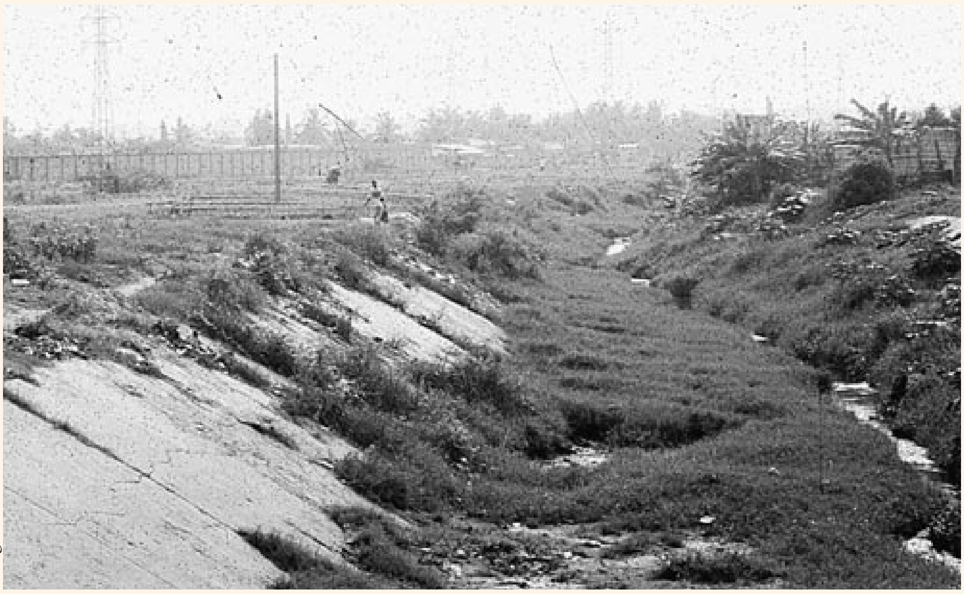
Notes

1. Human excreta is not included in organic wastes for the purposes of this discussion.
2. It should be noted that far more urban organic solid waste reaches farms via direct delivery by waste collection crews, 'mining' of garbage dumps and the cultivation of old dump sites than from compost plants (Rosenberg & Furedy 1996 pp 72-73, Nunan 2000).
3. See http://www.recycle,mcmail.com/green.htm).
4. The point made by H. Shuval, with reference to WHO standards for wastewater re-use, that they are unnecessarily stringent for developing countries, may also apply to standards for soils and compost.

Reducing the **Health Risks of Using Wastewater** in Agriculture

Recommended Changes to WHO Guidelines

In many areas of the world, urban agriculture depends on water supplies for irrigation. Water is often extracted from rivers, and these may be contaminated with wastewater, discharged into the river with little or no prior treatment. In some areas, untreated wastewater is used for irrigation directly. Use of both can increase the risk of gastro-intestinal diseases for farm workers and their families, and for the consumers of the crops. Policy makers and farmers need to know what quality of water they can use, and what forms of wastewater treatment (or other health protection measures) can be employed. As the water available for irrigation often does not meet national standards or international guidelines for wastewater reuse, this poses a challenge to the safe development of urban agriculture.



Margaret Armar-Klemesu

Major drains carrying domestic and other waste in Accra

Standards for wastewater reuse in many countries have been influenced by the WHO (1989) health guidelines (table 1), and the USEPA/USAID (1992) guidelines (which are much stricter). The WHO guidelines are proposed as a guide for policy makers as to which wastewater treatment processes, crops and irrigation methods are appropriate for safe agricultural production. They are not meant as standards for daily water monitoring at a local level. The WHO guidelines recognise the benefits that can be gained from using appropriately treated wastewater in agriculture, and aim to promote safe use of wastewater, and take into account the social, epidemiological and economic conditions that occur in specific countries.

Guideline standards are set for microbiological indicators of faecal pollution: faecal coliform bacteria and for nematode eggs. The first is intended to protect exposed persons from bacterial and viral infections (e.g. salmonella) and the latter, from helminth (and protozoal) infections.

The WHO guidelines have been influential in setting the standard in parts of Europe, Asia, and Latin America. They have been successful in raising awareness of the need for wastewater treatment and wastewater quality standards for agriculture and in proposing guideline limits that are achievable through comparatively low-cost treatment methods. However, many countries have not set wastewater standards whereas other countries do not possess the structural capacity or financial resources to apply appropriate wastewater treatment to achieve them.

Glossary of terms

- *Enteric infections* – infections of the alimentary canal (gut)
- *Guideline limits* – level at which persons exposed to water of this quality would not be at risk of infection
- *Faecal coliforms* – bacteria found in the faeces of warm blooded animals; the numbers found in water indicate the level of faecal or sewage pollution and the numbers found in treated wastewater indicate the effectiveness of wastewater treatment
- *Nematode* – round worm
- $\leq$ less than or equal to

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WHO is currently revising the 1989 guidelines to take into account new evidence. This paper summarises the main recommendations of a review of epidemiological, microbiological and risk assessment studies and their implications for the WHO guidelines (Blumenthal et al, 1999, Blumenthal et al 2000). The article gives recommendations for changing the guidelines and proposes appropriate wastewater treatment methods that can be used to achieve the new microbiological guideline limits. The results of the official WHO review should be available in early 2002. Policy makers need to regulate the use of water for irrigation, according to the degree of treatment and the type of crops grown. Plans may need to be made for providing wastewater treatment or restricting the type of crops which farmers can grow. Farmers need to be made aware that they are putting their health at risk by using contaminated water and they may wish to put pressure on their municipalities to provide them with safe water for agricultural use.

SETTING MICROBIOLOGICAL GUIDELINES

Currently three methods are used for establishing microbiological-quality guidelines and standards for treated wastewater reuse in agriculture: (I) the measurement of faecal indicator organisms in the wastewater, (II) the determination of (excess) cases of associated diseases in the exposed population, and (III) the use of a model-generated estimated risk. In the review of the guidelines, method II, (using epidemiological studies and microbiological studies) and method III, (using model-based quantitative microbial risk assessment) were used.

In the following, the wastewater guideline standards for unrestricted and restricted irrigation will be considered here. Firstly the current standards will be discussed, and whether evidence suggests that these are appropriate (sufficient) for limiting health risks. Subsequently, some examples of studies of wastewater quality monitoring will be given, and whether they indicate that the standards need to be changed. The 1989 WHO Guidelines are given below. In the text, the reader is referred to this table and to the table at the back of this article, in which revisions to these guidelines are proposed.

UNRESTRICTED IRRIGATION

This refers to the situation where water may be used to grow any crops using any irrigation method without health risks including crops that can be eaten raw.

Category A: Faecal Coliform (FC) guideline limit ≤1000 per 100ml

The results of studies on consumer risks do not suggest the need to change the WHO guideline, of $\leq 10^3$ FC/100ml for unrestricted irrigation.

Epidemiological studies suggest that risks of infections are significant only when the guideline is exceeded by a factor 13. Microbiological studies in Portugal (Vaz da Costa Vargas et al 1996) indicate that the *crop quality,* of crops irrigated with *water* just exceeding the guideline value, remained within the recommendations of the International Commission on Microbiological Specifications for Foods (1974), which is set at $\leq 10^5$ FC per 100g fresh weight for vegetables eaten uncooked. This suggests that the WHO guideline is appropriate in hot climates. Nevertheless, in situations where there are insufficient resources to reach the standard of 1000 FC/100ml for irrigation water, a more relaxed guideline of

Table 1. The 1989 WHO guidelines for the use of treated wastewater in agriculturea

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

a *In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.*

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 cone 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 be used.*

10^4 FC/100ml could be adopted. This should be supplemented by other health protection measures.

Nematode egg guideline limit ≤1 egg/litre

This guideline limit appears to be adequate to protect consumers of cultivated vegetables, which are spray-irrigated with effluent of consistent quality and at high temperatures. This is not necessarily the case for consumers of vegetables, which are surface-irrigated with such effluent at lower temperatures.

Studies show that irrigation with wastewater of the WHO category A guideline quality resulted in no contamination of lettuce at harvest or very slight contamination on a few plants (6%) with eggs that were either degenerate or not infective. In Brazil it was shown, that a few nematode eggs on harvested plants were viable but not embryonated (<0.1 Ascaris galli eggs per plant irrigated with 1-10 eggs per litre). So crops with a long shelf life might represent a potential risk to consumers if these eggs had time to become infective.

Epidemiological data indicate that factors in the field may alter the situation. Children who ate field vegetables irrigated with water of (1 nematode egg/litre within the guideline), had a similar prevalence of *Ascaris* infection as when the irrigation was with untreated wastewater (Peasey et al, 2000). It is therefore recommended that a stricter guideline of ≤0.1 eggs per litre is adopted. A guideline of ≤1 nematode-egg/litre may be adequate where crops with a short shelf life are grown (e.g. salad crops), or where the aim is to control disease intensity instead of trying to prevent transmission of infection.

RESTRICTED IRRIGATION

This applies to water used for irrigating a restricted range of crops, for example, cereals, fodder crops, pasture, trees, and crops, which are processed before consumption.

Category B: Faecal Coliform guideline limit not set

The WHO Guidelines do not include a limit for faecal coliform bacteria for this category, due to the lack of evidence of a risk of bacterial and viral infections for farm workers and nearby residents.

Recent evidence of enteric infections in farming families in direct contact with partially treated wastewater and in populations living near sprinkler irrigated fields, suggests that a FC guideline should be added when the water quality exceeds 10^6 FC/100ml.

Data from prospective epidemiological studies in Israel and the USA, suggest that a level of ≤10^5 FC per 100 ml would protect both farm workers and nearby population groups from infection via direct contact or wastewater aerosols when spray/sprinkler irrigation was used (Shuval et al., 1989 and Camann et al. 1986). This refers to category B1 in the table.

Data from Mexico, however, show that in a situation under flood and furrow irrigation with partially treated wastewater from urban areas, with direct contact, there may still be a risk of diarrhoeal disease at a level of 10^3-10^4 FC per 100ml (Blumenthal et al, 1998). Therefore, a reduced guideline level of ≤10^3 FC per 100ml would be safer where adult farm workers are engaged in flood or furrow irrigation (Category B2 in the table) or where children are regularly exposed (Category B3).

Where there are insufficient resources to provide treatment to reach this stricter guideline, a guideline of 10^5 FC per 100ml should be supplemented by other health protection measures (for example, health education concerning wastewater, and the importance of hand washing with soap after wastewater contact).

Nematode Egg: guideline limit ≤1 egg/litre

The guideline limit is adequate if no children are exposed (Category B1 and B2), but a revised guideline of ≤0.1 egg per litre is recommended if children are in contact with the wastewater through irrigation or play (Category B3).

Children in contact with effluent from a storage reservoir which met WHO Guidelines had increased prevalence and intensity of *Ascaris* infection, but when the effluent had been stored in two reservoirs and no nematode eggs were detectable, there was very little excess *Ascaris* infection in any age group (Cifuentes, 1998). Here also a stricter guideline of ≤0.1 eggs per litre is recommended where children are exposed to irrigation water.

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Alternatively, a country with limited resources aiming at disease control could adopt a less strict guideline and adopt additional health protection measures; such as, human exposure control and drug treatment

WASTEWATER TREATMENT AND OTHER HEALTH PROTECTION MEASURES

Appropriate wastewater treatment is essential to ensure that the wastewater microbiological quality guidelines are achieved. In many situations in developing countries, wastewater treatment in *waste stabilisation ponds* is recommended. These systems comprise one or more series of anaerobic, facultative and maturation ponds. They are shallow, usually rectangular, "lakes" into which wastewater continuously flows and from which an effluent is discharged. Anaerobic and facultative ponds are primarily for the removal of organic matter, although they are very effective in removing intestinal nematode eggs and *Vibrio cholerae* (Ayres et al, 1992, Oragui et al, 1993). Maturation

Table 2 Recommended revised microbiological guidelines for treated wastewater use in agriculture[a]

Category	Reuse Conditions	Exposed group	Irrigation technique	Intestinal nematodes [b] (arithmetic mean no. of eggs per litre [c])	Faecal coliforms (geometric mean no. per 100ml [d])	Wastewater treatment expected to achieve required microbiological quality
A	***Unrestricted irrigation***					
	A1 *Vegetable and salad crops eaten uncooked, sports fields, public parks* [e]	*Workers, consumers, public*	*Any*	≤ 0.1 [f]	≤ 10^3	*Well designed series of waste stabilisation ponds (WSP), sequential batch-fed wastewater storage and treatment reservoirs (WSTR) or equivalent treatment (e.g. conventional secondary treatment supplemented by either polishing ponds or filtration and disinfection)*
B	***Restricted irrigation***					
	Cereal crops, industrial crops, fodder crops, pasture and trees [g]	***B1*** *Workers (but no children <15 years), nearby communities*	*(a) Spray/ sprinkler*	≤ 1	≤ 10^5	*Retention in WSP series incl. one maturation pond or in sequential WSTR or equivalent treatment (e.g. conventional secondary treatment supplemented by either polishing ponds or filtration)*
		B2 *As B1*	*(b) Flood/ furrow*	≤ 1	≤ 10^3	*As for Category A*
		B3 *Workers including children <15 years, nearby communities*	*Any*	≤ 0.1	≤ 10^3	*As for Category A*
C	*Localised irrigation of crops in category B if exposure of workers and the public does not occur*	*None*	*Trickle, drip or bubbler*	*Not applicable*	*Not applicable*	*Pretreatment as required by the irrigation technology, but not less than primary sedimentation,*

a In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.
b Ascaris and Trichuris species and hookworms; the guideline is also intended to protect against risks from parasitic protozoa.
c During the irrigation season (if the wastewater is treated in WSP or WSTR which have been designed to achieve these egg numbers, then routine effluent quality monitoring is not required).
d During the irrigation season (faecal coliform counts should preferably be done weekly, but at least monthly).
e 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.
f This guideline can be increased to ≤1 egg per litre if (i) conditions are hot and dry and surface irrigation is not used, or (ii) if wastewater treatment is supplemented with anthelmintic chemotherapy campaigns in areas of wastewater re-use.
g In the case of fruit trees, irrigation should cease two weeks before fruit is picked and no fruit should be picked off the ground. Spray/sprinkler irrigation should not be used.

ponds are used mainly for the removal of excreted bacteria and viruses. In arid and semiarid areas the use of *wastewater storage and treatment reservoirs* is beneficial as they permit "the whole year's" wastewater to be used for irrigation (rather than that produced during the irrigation season only). This enables an area two to three times bigger to be irrigated. A single reservoir, receiving anaerobic pond effluent is suitable if the reservoir contents are used only for restricted irrigation, as the long retention time ensures the settlement of all helminth eggs (and as long as no children are exposed to the effluent). Three parallel reservoirs, operated as sequential batch systems, are needed to permit unrestricted irrigation. Design criteria for both systems are given by Mara (1997). Conventional treatment processes often still require secondary treatment, filtration and disinfection, to meet the revised guidelines. The high cost and difficulty in operating conventional treatment plants, means they are not recommended where the other two systems can be used. Sufficient land may not be available for building waste stabilisation ponds in the town or city itself, but may be available in the peri urban areas.

Even though it is the best health protection option, wastewater treatment for unrestricted irrigation may not be possible whereas that for unrestricted irrigation is (often for reasons of cost). Use of localised irrigation does not require achievement of water quality but it is an expensive system. Worker protection can theoretically be achieved at low cost by the provision of obligatory footwear, but can be difficult to achieve in practice. The hygienic handling of harvested crops is also important; recommendations are given by WHO (1998). Examples of the use of other health protection measures in a specific country setting are given by Peasey et al (1999). Community interventions using health promotion programmes and/or regular drug treatment programmes can be considered, in particular where no wastewater treatment is provided or where there is a time delay before treatment plants can be built.

"Water is too precious a resource to be used only once before returning to nature." This is what Sandberg (1992) said about the inseparable link between people and water.

IAGU

Using wastewater for irrigation in Senegal

Though seemingly trivial, this statement is pertinent as we realise how difficult it is to satisfy all water needs, encompassing domestic needs, agricultural activities, residential and recreational needs. This competition is especially tough in dry climates of the Sahelian zone, such as in Burkina Faso, Mauretania and Senegal – the three countries on which we are focusing our attention. Here, water is the major stumbling block to developing agricultural activities, and domestic needs win out over agricultural activities in the competition for water.

The Use of Wastewater for Urban Agriculture

The Example of Dakar, Nouakchott and Ouagadougou

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Urban agriculture is a dynamic sector, characterised by the proximity of production and consumption sites. Its performance is ultimately limited by the difficulty of accessing water. One strategy to offset the water deficit is to re-use wastewater. Such a practice has to be examined closely for its advantages and disadvantages in relation to the issue of urban and periurban agriculture. In this article, we make a plea for judicious use and re-use of water, subject to appropriate treatment methods.

If properly handled, wastewater can fulfil many needs

DEVELOPMENT OF URBAN AGRICULTURE

Urbanisation is rapidly growing, with 43% of the total population in Senegal living in cities; 35% in Mauretania; and 25% in Burkina Faso. Population growth has turned urban zones into a large market capable of absorbing the local production of urban agriculture while minimising transport, storage, and preservation costs. At the same time as secondary towns have developed, the need for horticultural products has increased, leading to further development of urban agriculture.

Due to the high demand in urban centres for foodstuffs such as fruits and vegetables, but also because of high un- and under-employment, the surface area set aside for growing vegetables in Senegal has increased from 8,000 hectares in 1986 to 12,050 ha in 1997. Likewise, vegetable exports have progressed from 4,500 tonnes in 1994/95 to 5,857 t in 1995/96. In Mauretania, the fruit and vegetable yield reached 65,000 tonnes in 1997, of which 18% came from the city of Nouakchott.

Due to poor access to water and nutrient inputs, alternative strategies have developed to re-utilise wastewater and to recycle solid waste. Solid waste and wastewater are re-used in urban horticultural areas, namely for soil enrichment and to overcome water constraints. For example, at Dakar's main waste disposal site near the village of Mbeubeuss, a group of people reclaim waste material called *terrou*. The *terrou* develops from waste material deposited over a number of years, and is used by farmers as a kind of fertiliser. The re-use of wastes in agriculture can provide a means of enhancing fertility in soils usually low in organic matter, as an alternative to chemical fertilisers.

In the three countries, the main constraints hampering the increase of urban agriculture are:

- *conflicts* between the authorities and the market gardeners (Zallé 1999). Urban agriculture is seen to be conflicting with urban politics, which is why it suffers from inopportune administrative decisions and a lack of specific legislation on UA (e.g. no legal basis or appropriate supervision) and interest;
- *economic and technical problems* (regarding food preservation, processing, commercialisation, etc.) leading to decreased productivity and income; and
- *difficult access* to water sources and inputs.

WASTEWATER - FROM DISREGARD TO RECOGNITION

In the cities of Senegal, Burkina Faso and Mauretania, agricultural activities, such as horticulture, take advantage of existing hydrological networks, including shallows and valleys liable to flooding. The widespread opinion was that wastewater was not only worthless, but also dangerous. For this reason, producers in Dakar built dams to prevent wastewater from invading their plots of land. However, since a number of farmers noticed the higher yield from fields 'irrigated' by wastewater leaking out of a ruptured sewer, nowadays, urban farmers increasingly appreciate the use of wastewater. If properly handled, wastewater can fulfil many needs.

The benefits of wastewater use in urban agriculture

A principal reason for using wastewater in urban agriculture is the lack of adequate water sources. Dakar, for example, already has a daily drinking-water deficit of 100,000 to 162,000 m^3. Besides the increasing scarcity of water resources, another argument for using wastewater is its nutrient content, something appreciated by the users, since artificial fertilisers are expensive. This aspect makes it further difficult to convince farmers of the health risks involved: in the farmers' perception, diseases are the result of supernatural spirits and cannot be explained in rational terms.

In the urban zones of Dakar, Ouagadougou, and Nouakchott, fruits and vegetables are watered with wastewater. Wastewater is readily available and also plentiful; e.g. Dakar currently produces 100,000 m^3 of wastewater a day (Niang 1999). This will continue to rise to ever greater quantities as the population continues to grow. The presence of water containing fertilising constituents guarantees considerable gains in productivity. For example, 70% of market gardeners in Dakar who get their water from *céanes*[1], say that they use close to 20 m^3 of water a day, while 86% of the market gardeners who use untreated wastewater affirm that they do not use more than 4 m^3 of water a day (ibid.). Analyses performed on wastewater in Dakar report high values of BOD_5 (Biological Oxygen Demand) attesting to a marked presence of organic matter, and high concentrations of nitrogen and phosphorus (essential nutrients for proper plant development).

The harmful aspects of wastewater use in urban agriculture

The utilisation of wastewater will remain a reality in urban agriculture. Nevertheless, using wastewater can cause problems to the health of the general population and the environment if used without prior treatment. The figures found in Dakar (see Table 1) indicate that wastewater may cause significant harm when used for irrigation in market gardening. The high concentration of suspended matter in wastewater leads to the clogging of the interstitial spaces in the soil. Worse, the high contamination of the water by Faecal Coliforms and Streptococci has a negative effect on the microbiological quality of the water, and on human health. The World Health Organisation (WHO) standards indicate that the water should not contain a concentration of Faecal Coliforms in excess of 1,000/100 ml and a concentration of intestinal nematode eggs in excess of 1/1000 ml (see page 25). However, Table 1 shows that these concentrations are much higher in Dakar (Niang 1999).

Parasitological analyses by Niang (1999) on common vegetables including lettuce, parsley and carrots have shown contamination by parasites (amoebas, etc.), which can transmit diseases such as diarrhoea, abdominal pain and parasitic infections, to people if the vegetables are consumed raw or poorly cleaned (see Table 2). *Ankylostoma*, ascarid and *Trichocephalus* worm species are intestinal nematodes that have a considerable latent period and do not require an intermediate host in order to spread to humans. The presence of eggs and larvae shows how much the vegetables in question are contaminated.

Table 1: Urban agriculture in Dakar: Characteristics of wastewater and drinking water

Parameters	Wastewater	Drinking water
pH	*8*	*7.7*
Conductivity (ms)	*1,900*	*1,100*
Residual dry matter (mg/l)	*900*	*800*
Chloride ions (mg/l)	*400*	*200*
Suspended matter (mg/l)	*1,200*	*0*
BOD_5 (mgO_2/l)	*500*	*2*
NH_4^+ (ngN/l)	*127*	*1*
PO_4-3 (ngP/l)	*16*	*2*
Faecal Coliforms (Number/100 ml)	2.8×10^7	*0*
Faecal Streptococci (Number/100 ml)	1.8×10^7	*0*

(Source: Niang 1999)

Table 2: Concentration of parasites found on vegetables per 100 m of rinsing water

Parasites	Lettuce	Parsley	Carrots
Amibe minuta (cysts)	*13*	*6*	*0*
Amibe hystolitica (cysts)	*9*	*14*	*0*
Anguillules (larvae)	*0*	*20*	*0*
Ankylostoma spp	*2 larvae*	*3 eggs*	*0*
Ascarids (eggs)	*40*	*0*	*0*
Budding yeast	*Many*	*17*	*0*
Nemathelminths	*0*	*7*	*11*
Platyhelminths	*0*	*4*	*4*
Trichomonas (eggs)	*13*	*12*	*3*
Trichocephalus spp (eggs)	*4*	*0*	*0*

(Source: Niang 1999)

Ms. Inés Beernaerts

Water sampling for laboratory analysispicture (La Fulani)

Domestic animals - that constitute intermediate hosts - often drink water used for rinsing contaminated vegetables, as well as eating the vegetable peels. Since these animals are then consumed by people, the cycle of contamination is quickly established.

Research undertaken in Ouagadougou in 1997, looked at the sanitary impact of wastewater re-use. It shows that the children of market gardeners up to the age of 4 had a higher rate of mortality from diarrhoea and parasitic infections than those of the same age group of the general population. During an epidemic in 1987, 400 cases of typhoid and paratyphoid A and B fever occurred in the region of Dakar. The epidemiological analyses showed that this epidemic was caused by the use of wastewater by the market gardeners to water their vegetables (Seck 1998: 14)

Socio-cultural acceptance of wastewater use despite recognised sanitary impact

Notwithstanding the negative health impacts made evident by different studies on this question, producers resist the idea of a possibility of health risks linked to the re-use of untreated water. In Ouagadougou, the market gardeners are not able to understand that invisible pathogens can contaminate them, their family, or those who eat their vegetables (Cissé 1997: 191). Consumers in Dakar have the same perception as market gardeners in Ouagadougou, on the risks involved in watering produce with wastewater. Results from a study by Seck (1998) show that 40% of individuals asked do not recognise any risk in consuming vegetables produced with wastewater.

These examples show the adherence to, or acceptance of, wastewater re-use, but also show how little success any attempt towards banning wastewater use would have. The following illustrates this last point: market gardeners in Dakar are aware of the rules on using untreated wastewater - it is prohibited for the cultivation of vegetables, but not for fruit trees. To get around this, farmers normally grow the more profitable vegetables when water is available from the *céanes*[1], and then mix vegetables and fruit trees when using wastewater. The fruit trees will then at least guarantee them some income in case of intervention by the health service authorities.

Producers are reluctant to give up wastewater use. Their knowledge of the cause and effects of diseases remains limited, which is important to consider when elaborating strategies concerning the practice of wastewater use.

CONCLUSION

The expansion of urban agriculture in Burkina Faso, Mauretania and Senegal is hindered by diverse constraints, of which the availability of water remains the main one. Wastewater has as a result become an important source for supplying water for irrigation purposes or as an additional water source. The health risks, however, call for urgent reflection and action.

Simply banning the use of wastewater is not an appropriate solution. Its use has to be accompanied by appropriate measures to achieve better quality standards like:

- ❖ purification of wastewater before use;
- ❖ modification of the irrigation method of sprinkling;
- ❖ irrigation via trenching systems, avoiding direct contact;
- ❖ restriction of crop production and marketing in terms of raw consumption;
- ❖ adoption of more hygienic techniques for spreading manure (such as underground spreading); and
- ❖ raising farmers' awareness about health risks (e.g, wearing boots and gloves).

Wastewater use has advantages, provided the necessary precautions are taken to protect the environment and public health. Judicious use of wastewater does not necessarily allow for reduced pollution of natural sites or for increased agricultural productivity.

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Note

1 A céane is a hole dug in the ground and widened according to its depth. In peat shallows, it is close to the surface between 0.5 and 2 m. In sandy soil, its depth increases to 5, sometimes 6 m. Beyond this depth, a well must be constructed.

Periurban **Irrigated Agriculture and Health Risks** in Ghana

In Africa, more than one-third of the population already lives in cities, and over the next 25 years, the rapid urbanisation of Africa could lead to decreasing food security in the cities. In Ghana, the urban population is growing at an estimated annual rate of 4.1% compared with the overall population growth of 3%. Among major urban problems are those related to unemployment and under-employment, as well as high food prices especially due to the high costs of marketing food products. The growing demand for fresh and perishable agricultural produce in the major cities is driving the development of (peri)urban agriculture. This demand is not seasonal, necessitating year-round production, heavily dependent on irrigation.

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It has been established that (peri)urban farm produce in Ghana is contaminated by microbial organisms at both the production and the distribution points. Three main sources of contamination have been identified:

- irrigation water, whether it be wastewater, normal surface water or pipe-borne water when stored in ground reservoirs;
- fertiliser inputs; and
- the handling and storing of produce at points of sale.

Many pathogenic bacteria such as *Escherichia coli* and *Salmonella*, among others, have been identified in addition to some gastro-intestinal helminths and protozoa, indicating gross contamination most likely of faecal matter.

In spite of these risks, (peri)urban agriculture, driven by an increasing demand from a rapidly growing urban population will continue to expand within the limits of available land resources. Water quality and soil fertility will have to be managed in synergy with the cleaning up of the urban environment through the recycling of wastewater and solid waste.

ROLE OF IRRIGATION AROUND KUMASI AND ACCRA

Most vegetable farmers in the (peri)urban area of Kumasi consider irrigated horticulture to provide their primary source of revenue. They move from one site to another as dictated by water availability. Some 700 farmers are thus irrigating about 300 ha at 17 sites around and within Accra.

Currently, (peri)urban irrigation provides vegetables year-round and contributes to the improvement of the nutritional status of city inhabitants. The proximity to the markets allows for a large array of fresh products of good quality. However, water is a constraint because the cost of pipe-borne water makes it unaffordable to farmers. The use of untreated wastewater for irrigation has therefore become a widespread practice, with its attendant health hazards.

HEALTH HAZARDS AND IRRIGATION WATER QUALITY

A recent study of two sites in the Accra Metropolitan Area (Sonou M. et al, forthcoming) revealed that wastewater was the most frequently used water for irrigation purposes. As much as 60% of the farmers interviewed at Dzowulu Power Pool Station (67.7%) and at Castle Parks and Gardens (32.3%) confirmed the use of this type of water. Less than a quarter (23.3%) use pipe-borne water while approximately 17% use piped water stored in a ground reservoir.

Laboratory analysis of samples collected from twelve different sources in 1999 (Cornish et al, forthcoming) all proved to be contaminated with bacteria, beyond the limits of the 1989 WHO microbiological guidelines for wastewater use in agriculture. Two other studies (Owusu, 1998) and (Armar-Klemsu et al, 1998) also reveal that (peri)urban vegetable farmers around Accra and Kumasi have been using highly polluted water for their irrigation needs.

City authorities fear that the vegetables grown under these conditions are a threat to public health. Hence, the Accra Metropolitan Assembly of 4 August 1995 enacted a by-law for the "Growing and Safety of Crops," as follows: "No crops shall be watered or irrigated by the effluent from a drain from any premises or any surface water from a drain which is fed by water from a street drainage;" and furthermore, "A person who contravenes these by-laws commits an offence, and is liable on summary conviction to a fine not exceeding ¢100,000, or in default o f the payment of the fine, to a term of imprisonment not exceeding three months, or both." (Local Government Bulletin 1, 1995: 190). These by-laws are not enforced (Armar-Klemsu M et al, 1998).

Carrying water from the drain to the field (Marine Drive)

The Ghana Tourist Board, the Hotel Catering and International Management Association (HICIMA) and the Vegetable Exporter and Producer Association of Ghana have all expressed serious concerns about the hygienic cultivation of vegetables in Ghana. They have launched a campaign called "Save Ghana Vegetables" and requested FAO technical assistance to formulate a project for the development of safe and environmentally sound (peri) urban irrigated agriculture (Westcot, 1997).

HEALTH HAZARDS ASSOCIATED WITH MARKET HANDLING AND STORAGE OF PRODUCE

Another main source of microbiological contamination at the market level is poor handling and storing practices of vegetables by market women. During an interview conducted recently (Sonou et al, forthcoming), 100% of women claimed they wash the vegetables in water before selling them. Personal observation of the storage conditions has, however, revealed that the vegetables are generally exposed and are frequently visited by houseflies and other insects including cockroaches. Table 1 shows the bacteria counts obtained from vegetables at two different market places. The common micro-organisms isolated from vegetable samples include *E. coli*, *Pseudomonas*, *Enterobacter cloacae*, *Salmonella arizonae* (Table 2). Other organisms (helminths and protozoans) identified on vegetables collected from the field and market include free-living soil nematodes, flagellates and *Balantidium coli*.

It appears that vegetables produced with tap water are contaminated with health threatening micro-organisms. The source of such contamination can be ascribed to non-hygienic produce handling at farm level or at market place. It may also be caused by improper solid waste recycling for soil fertility management.

HEALTH HAZARDS ASSOCIATED WITH SOIL FERTILITY MANAGEMENT

A third source of potential contamination is found in the manure used by farmers in the management of soil fertility. Poultry manure, which represents 75% of the organic fertiliser used, generally contains Faecal Coliforms ($1.30.10^6$/g) and Faecal Streptococci ($3.4.10^6$/g) (Westcot, 1997). This is evident even in situations where pipe-borne water was used for irrigation. Vegetables cultivated with manure are highly infected by bacteria, indicating contamination from a faecal source (Sonou et al, forthcoming).

Recycling solid waste and wastewater into (peri)urban horticultural production contributes to cleaning the environment. However, this is associated with potential health risks which call *inter alia* for (i) careful agronomic practices including water quality and soil fertility management; (ii) integrated pest management (IPM); and (iii) health sensitisation and education programmes.

CONCLUSIONS AND RECOMMENDATIONS

The following recommendations could contribute to the development of a safe and environmentally sound (peri)urban irrigated agriculture (Sonou, 2000):

- ❖ training in the management of water quality, soil fertility and Integrated Pest Management;
- ❖ sensitisation and education campaigns targeting (peri)urban farmers and market women through the most accessible media, and extension services;
- ❖ implementation of appropriate health protection measures to accompany the use of low quality water in irrigation;
- ❖ development of technologies that promote environmental sanitation and the treatment of wastewater before re-use in (peri)urban agriculture;
- ❖ promotion of irrigation techniques and technologies that (i) reduce the frequency and duration of human/irrigation-water contact (at times when the level of contamination is assumed to exceed WHO standards); (ii) prevent direct contact between the product and the contaminated irrigation water, as the case may be for drip irrigation;
- ❖ design of a practical method to identify the geographical extent of contamination and to define the priority for action to regulate the use of contaminated water in (peri)urban irrigation; and
- ❖ design and implementation of a water-quality certification programme based on the level of contamination and aimed at protecting consumers. This may be linked to a national strategy to control and reduce the contamination of water used in agriculture.

Table 1: Bacteria counts obtained from vegetables from the two different markets

Vegetable type	Mokola (CFU/ml)			Agbogbloshie (CFU/ml)		
	TBC	*TC*	*TFC*	*TBC*	*TC*	*TFC*
Cucumber	*7.6×10^5*	*1.9×10^5*	*7.1×10^4*	*1.6×10^5*	*2.9×10^4*	*6.9×10^4*
Carrot	*7.3×10^4*	*7×10^3*	*3.8×10^4*	*1.15×10^4*	*1.6×10^4*	*9.0×10^3*

Amoussou-Gohoungo in Sonou et al.(2000)

Table 2: The common micro-organisms isolated from vegetable samples

Vegetable type	Source of water	Organisms isolated
Spring onion	*Tap water*	Pseudomonas spp; *Proteus mirabilis*
Spring onion	*Drain*	
Lettuce	*Tap water*	E. lermannii; Citrobacter freundii
Lettuce	*Drain*	Salmonella arizonae; Pseudomonas spp
White radish	*Tap water stored underground*	E. coli; Klebsiella spp
Green pepper	*Tap water stored underground*	E. coli *(from S-F)*
Green pepper	*Drain*	Pesudomonas spp
Cucumber	*Not known*	Citrobacter freundii
Carrot	*Not known*	Salmonella arizonae

Amoussou-Gohoungo in Sonou et al.(2000)

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Ecological Sanitation
Closing the Loop

One of the most potent forces in the world today is urbanisation. Some of the seemingly disconnected problems associated with urbanisation - water scarcity, food insecurity and pollution - are really the manifestation of several underlying assumptions and actions. One assumption is that there are no limits to resources such as water and land. Another is that the environment can assimilate the wastes that we produce from using these resources. These assumptions lead to linear flows of resources and wastes that are not reconnected. The technological developments to serve these linear flows have become part of the problem, not the solution.

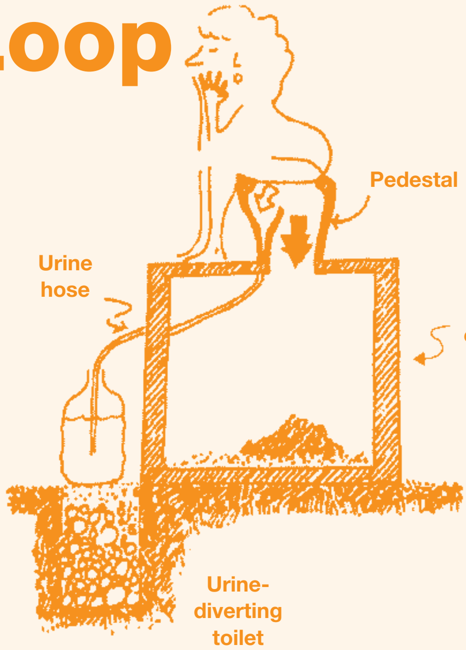

Figure 2: Urine-diverting toilets facilitate treatment and re-use.

Today, nearly half of humanity has no access to any type of sanitation (WHO and UNICEF 2000). The rest of humanity relies on conventional approaches to sanitation, which fall into one of two categories: water-borne systems and pit latrines. Both 'flush and discharge' and 'drop and store' technologies were built on the premise that the nutrients we excrete have little value, and that waste is suitable only for disposal. Consequently, the environment is polluted, nutrients are lost, and a wide array of health problems result (Esrey 2000).

The ecosystem loop - excreta ↔ food

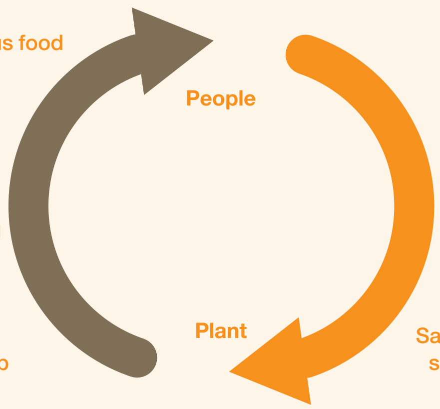

Figure 1: Ecological sanitation is safe, green and valuable

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Ecological sanitation (Esrey 1998) represents a shift in the way people think about and act upon human excreta. It is an ecosystem approach (Figure 1) that recognises the need and benefit of promoting human health and well-being, while at the same time recovering and recycling nutrients, and conserving and protecting water sources. It represents a closed-loop approach, and is an attempt to move away from linear solutions of waste disposal towards a circular flow of nutrients.

DESIGN FEATURES

Conventional sanitation solutions assume that the environment can handle the waste, or they shift the burden to downstream communities. Ecological sanitation, on the other hand, minimises the reliance on external inputs, while simultaneously reducing the output of wastes from the system.

There are two basic design features of ecological sanitation. One is urine-diversion, in which urine and faeces are never mixed (see figure 2). The pedestal has a dividing wall, in which the urine exits from the front of the toilet, and faeces drop below the toilet from the back of the bowl. Another design combines urine and faeces, at which point urine and faeces can be processed together or seperated. In either case, it is possible to manage urine, faeces or excreta with little or no water, and it is also possible to keep the end-product out of ground and surface waters.

Pathogens are treated close to the point of excretion. Nearly all pathogens in excreta are found in faeces, while urine is sterile with few exceptions (e.g. *Schistosoma haemotobium* - a trematode worm which causes Bilharzia or Schistosomiasis). If faeces are kept separate from urine, the pathogens in faeces are much more easily treated in an ecological toilet without the use of harmful chemicals or complex processes and treatment plants. Microbiological testing on urine diversion toilets is being done in a number of countries. Evidence to date (Stenström 1999) indicates that the addition of lime or ash helps to desiccate faeces and raise the pH, which can effectively kill off pathogens within several months. Faeces, once desiccated, may be returned to soil or composted with organic household refuse if there is some concern that pathogens still exist. If it is suspected that pathogens survive the desiccation/pH phase, they can be killed within days at temperatures above 50°C or within a relatively short time during thermophilic composting (Feachem et al. 1983). Of course, over time pathogens will die if kept out of water and left undisturbed by weather or animals. This period may be up to two years if *Ascaris* ova are present.

If urine and faeces are combined, as is usual in conventional systems, it is harder to render excreta safe, though not impossible. More time, thermophilic composting and sometimes chemicals, such as chlorine, are necessary then to kill bacteria. In general, conventional sanitation solutions fail to treat excreta on- or off-site. Over 90% of sewage in developing countries is discharged without any treatment, into receiving bodies of water, and the figure for Latin America, which has the highest rates of water-borne systems, is 98% (Briscoe & Steer 1997).

Ecological sanitation also contributes toward the protection of human health by providing a healthy environment. Human excreta contain very low levels of heavy metals. For example, in Sweden urine contained less than 3.2 mg cadmium per kg of phosphorus (P), compared to 26 mg Cd/kg P in commercial fertilisers and 55 mg Cd/kg P in sludge (Jönsson et al. 1997). In addition, there has been some concern about the excretion of pharmaceuticals (Raloff, 1998). Many of these products may be partially or fully reconstituted when deposited into water, but when excreta are returned to soil, they appear to be broken down rapidly by soil micro-organisms (Stockholm Vatten et al. 2000). The uptake by plants should be negligible.

Returning nutrients to soils may restore soil fertility more than reliance on commercial fertilisers. Ecological sanitation is a household or community-managed operation. Recycling nutrients for home gardening is often the domain of women, who may get additional food or income. Treated excreta can also be packaged into plastic bags and sold as fertiliser to provide income (Morgan 1999). It is also well known that when women have control over resources, they are more likely to use those resources for food and health care of family members than will men.

EXAMPLES FROM AROUND THE WORLD

Achieving ecological sanitation solutions requires a change in how people think about and act according to human excreta. In some societies, human excreta are considered a valuable resource, and the handling of excreta poses no problem. In fact, urine has been used as a resource in many parts of the world for centuries. It was used in Europe for household cleaning, softening wool, hardening steel, tanning leather and dying clothes. The Greeks and Romans used it to colour their hair, and African farmers use it for fermenting plants to produce dyes. The Chinese pharmaceutical industry uses it to make blood coagulants. In other societies, excreta, and particularly faeces, have been considered dirty for centuries. Experience shows, however, that urine diversion is acceptable, and the handling of urine poses far fewer taboos than that of faeces. Many people do not know that faeces can be processed and converted into humus, with all the typical characteristics: pleasant-smelling, easy to handle as soil, and innocuous. Furthermore, experience shows that after people have become familiar with these systems, no flies or smells occur, and people install these toilets inside their homes.

Wallgarden

Ecological sanitation has been gaining momentum during the past decade

Ecological sanitation has been gaining momentum during the past decade. In most places where it is being tried, health issues have been at the forefront. Microbiological testing of excreta has occurred. However, methods have varied, and sample sizes are small due to the costs involved. In general, excreta can be safely processed, but failure to pay attention to maintenance, and insufficient or infrequent use of lime or ash, may fail to adequately destroy all pathogens. Anecdotal evidence from several locations indicate that people prefer vegetables grown with urine fertilisation, and in China people are willing to pay more for vegetables grown in urine (Mi Hua, personal communication, 2000).

In Mexico City, experimentation with fermented urine to grow food has shown that leafy vegetables do very well (Arroyo, personal communication, 2000). This includes lettuce, cilantro (coriander), parsley, celery, fennel, scented herbs, prickly pear, and chile piquin. Good results were obtained for cauliflower, broccoli, cabbage and root produce (turnips, carrots, beets and onions). Fruiting plants, such as tomatoes, squash, cucumber, peppers and aubergines have not done as well with fermented urine as with other fertilisers. This may be due in part to the continued use of nitrogen, in the form of fermented urine, during the fruiting process. When the subsoil is enriched with worm compost, the results for fruiting plants improve dramatically. In the case of tomatoes, produce is increased from 3 to 5 kg per plant when the compost is

Resource value of human excreta

Human excreta are comprised of two basic components, urine and faeces. Each has very different properties, they are produced in different quantities, and they require different care in processing. Published figures indicate that more than 1 litre of urine and less than 200 g of faeces, including moisture, is produced daily (Del Porto & Steinfeld 1997), depending on the type of diet, location, age, activity and health status. Urine contains nearly 80% of the total nitrogen found in excreta and about two-thirds of the excreted phosphorus and potassium. The majority of the carbon excreted, up to 70%, is found in faeces. The quantities shown above may suggest that excreta contain few nutrients. Each person urinates annually about 4 kg of nitrogen, 0.4 kg of phosphorus, and nearly 1 kg of potassium. Total excretion is 4.5 kg of nitrogen, more than half a kg of phosphorus, and 1.2 kg of potassium. This is the amount needed to grow a year's supply of grain for every person (Wolgart, 1993). In an urban setting of one million people, this equates to 4.5 million kg of nitrogen, nearly 600,000 kg of phosphorus, and more than 1.2 million kg of potassium. Although using only urine is valuable, both urine and faeces should be recovered and recycled to avoid long-term depletion of soils.

Bitter Gourd next to toilet in Kerala, India

Rooftop gardening in China using human urine (source Uno Winblad)

Conclusions so far indicate that the health risk is negligible

enriched with the phosphorus and potassium compounds from worm composting. Others (Guadarrama 2000) in Cuernavaca, Mexico have been experimenting with human urine as a source of nitrogen in organic vegetable production. The experiments compared human urine versus a control on the production of chard, celery and beets. For each vegetable yields were higher when urine was applied compared to the control. The central root, length of step and area of foliage was greater in urine fertilised vegetables, and no diseases or pests were found.

In Guangxi province, China, urine-diversion toilets (double-vault dehydration) are gaining momentum. Rooftop gardening (see foto) uses only urine to grow vegetables, such as tomatoes, cabbages, beans and pumpkins. Faeces are carted to the fields. Urine and faeces are used in fields to grow corn, rice and bamboo. In China, farmers have commonly used night soil, often untreated, to grow food. It has been recognised for centuries as a valuable fertiliser. A pilot project of 70 urine-diverting toilets has grown to over 30,000 toilets in both densely populated rural and urban areas. This effort has been supported at the top political level.

In a pilot project in Kerala, India, urine from toilets is diverted into a growing area attached to the back of the toilet. Bitter gourds are grown, which are sliced, fried and eaten. This first stage has met with success, and there is demand to have more toilets built. Island communities in the Pacific also have wash-water gardens, largely driven by the need to not pollute and destroy their livelihood - fishing. Some of the Island communities, such as Fiji, have wash-water gardens in schools as well.

In Zimbabwe, there has been much experimentation in the past few years with ecological sanitation. It is now spreading to periurban areas of Harare and to neighbouring countries, with various toilets designed for different purposes being tried. In addition to urine-diverting toilets, other ecologically sound toilet systems are also being used. The 'arbourloo' is a system in which both urine and faeces are deposited in a shallow pit. When it is nearly full, it is topped off with soil and allowed to digest and decompose for several months. At that time, trees are planted in the topsoil. A wide variety of fruit-bearing trees grow very well in this type of system. Guava, banana, mulberry and paw paw respond very well and grow very fast. Avocado, mango and citrus grow slower initially. All these fruit trees supply valuable micronutrients, improving the nutrient status of consumers.

In the mid 1990's, a number of ecological housing estates were built in Stockholm, Sweden. One of the main features built into the design was the development and testing of an ecosystem-based sanitation system with urine-diverting toilets. Urine was collected, stored and applied to the fields. Faeces were treated in the conventional manner. The Stockholm Water Company was the lead agency, and research is still being conducted on health, environment and social acceptance of the system. Conclusions so far indicate that the health risk is negligible, and the emission of nitrogen and phosphorus is reduced by 50-60% compared to conventional sewage. Urine has also been found to be a valid substitute for mineral fertilisers to grow cereals, with no negative impact on the crop or the environment. And, as reported above, urine contains less heavy metals than does conventional sewage or fertilisers.

Other countries throughout the world are experimenting with ecological sanitation. Not all are promoting the re-use and recycling of nutrients. Many of these initiatives have come about because of local problems, such as pollution or water scarcity. Today, support for ecological sanitation comes from many quarters: international agencies such as UNDP, UNICEF and donors such as Austria, Germany and Sweden as well as international NGOs such as CARE and Wateraid, and local and national NGOs.

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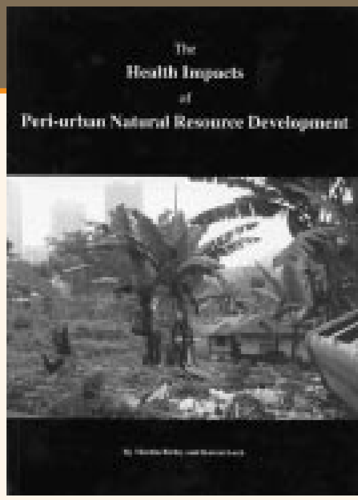
FURTHER READINGS ON HEALTH AND URBAN AGRICULTURE



REUSE OF WASTE FOR FOOD PRODUCTION IN ASIAN CITIES

Furedy C, Maclaren V & Whitney J. 1999. In: Koc M, MacRae R, Mougeot L & Welsh J (eds). For Hunger Proof Cities; Sustainable Urban Food Systems (Ottawa: International Development Research Centre), 136-144.

Asian communities have many practices involving the re-use of organic wastes in agriculture and aquaculture, even in urban areas. This paper discusses the health and economic aspects of the re-use of municipal waste in South and Southeast Asia. Recent research carried out in Bangkok, Bandung, Bangalore, Hanoi, Ho Chi Minh City, Jakarta, and Manila is used to suggest the potential for linking organic waste re-use and urban agriculture and aquaculture. Important constraints to the re-use of organic waste are its contamination and the greater cost of making compost, compared to chemical fertilisers. The paper suggests strategies for minimising these constraints and improving the marketability of organic wastes. Contamination can be reduced by collecting waste separately and by separating organics at source. Market research is needed to promote the use of compost. Health risks can be reduced through education and the amendment of agricultural practices. (abstract adapted from original)

THE COMPOSTING TOILET SYSTEM BOOK. A PRACTICAL GUIDE TO CHOOSING, PLANNING AND MAINTAINING COMPOSTING TOILET SYSTEMS: AN ALTERNATIVE TO SEWER AND SEPTIC SYSTEMS.

Del Porto D & Steinfeld C. 1999. The Center for Ecological Pollution Prevention (CEPP), 240 pages.

A number of wastewater management methods are given here, that may be viable and cost-saving alternatives to graywater disposal systems. The central theme deals with the design of a composting toilet, also known as a dry, waterless or biological toilet. Composting toilets are not only an alternative in places where septic tanks cannot be installed but they are also one of the most direct ways to avoid pollution and conserve water and resources. A very complete manual, full of practical information. The manual contains a useful glossary and a list of American state regulations. In spite of its apparent USA-focus, the content applies equally well to developing countries. (Wietse Bruinsma, WB)

HEAVY METAL POLLUTION IN SOILS IN CHINA: STATUS AND COUNTERMEASURES

Huamain Chen, Chungrong Zheng, Cong Tu & Yongguan Zhu. 1999. Ambio 28(2): 130-134.

Heavy metal pollution of soil greatly affects not only the yield and quality of crop, animal and human health, but also the quality of the whole environment. The current status and the effects of heavy metal pollution in China are reviewed in this paper. Soil pollution by heavy metals from sewage irrigation and metal mining, smelting and processing activities is serious. Urban enterprises also contribute to heavy metal pollution of soils in China. The effects of soil pollution on plants, animals and human beings are discussed, and effective countermeasures for pollution control are presented. (Kathleen Flynn, KF)

HEALTH EFFECTS OF URBAN WASTEWATER REUSE IN AGRICULTURE IN A PERI-URBAN AREA OF MARRAKECH (MOROCCO)

Amahmid O & Bouhoum K. 1999. Abstracts: Urban stability through integrated water-related management, 9th Stockholm Water Symposium, 9-12 August 1999, pp 124-126.

An epidemiological study was carried out to determine the impact of urban wastewater re-use in agriculture on the transmission of two protozoan infections, *giardiasis* and *amoebiasis*, to children in a periurban area of Marrakech. These two infections are pathogenic, and *giardiasis* has recently become recognised as the most frequent protozoal infection and is therefore becoming a major public health concern. An increase in the incidence of water-borne outbreaks of *giardiasis* is reported in many parts of the world, yet the role that sewage re-use has played on the transmission of these parasites is not established. (KF)

COMMUNITY-BASED TECHNOLOGIES FOR DOMESTIC WASTEWATER TREATMENT AND REUSE: OPTIONS FOR URBAN AGRICULTURE

Rose, Gregory D. 1999. Cities Feeding People Series, no. 27 (Spring). Ottawa: International Development Research Center.

This paper presents a comprehensive analysis of technologies for domestic human waste management in urban environments. The main part of the paper focuses on a review of natural or naturally based technologies which can be implemented as alternatives to centralised electromechanical treatment technologies. The paper looks at the spatial requirements, costs, advantages, drawbacks and effectiveness of on-site and off-site land-based and water-based technologies, including waterless latrines, biogas reactors, water hyacinth-based systems, duckweed-based systems, and sludge blankets. The author gives a limited amount of consideration to public health aspects in terms of re-use, fertilisation, irrigation, and disease vectors. He states that further research into the health aspects and guidelines for wastewater re-use in aquaculture is needed. The author argues in his conclusion that, in general, natural treatment processes are viable, but not without barriers and impediments. He concludes with strategic, technical, sociocultural and economic recommendations for research and action. (KF)

THE HEALTH IMPACTS OF PERI-URBAN NATURAL RESOURCE DEVELOPMENT

Birley MH, Lock K. 1999. Pembroke Place: Liverpool School of Tropical Medicine. ISBN 0 9533566 1 2. 185 pp.

This monograph is based on a report commissioned by the UK Department for International Development (DFID), which is conducting research into natural resources in periurban areas through its Natural Resource Systems Programme. In this study, the various health hazards in connection with the periurban interface are identified and systematically examined. Health issues are organised into categories of communicable diseases, non-communicable diseases, injury, malnutrition and psychosocial disorder. In a way, periurban communities may have to face the worst of two worlds, being subject to both traditional and modern health hazards. All major natural-resource-management themes in the periurban setting are closely examined, such as energy, agriculture, fisheries and waste management. Also, a procedure for health impact assessment is described which can be used in project design and operation. The final chapters provide a synthesis of important linkages and give a state-of-the-art overview of researchable themes that require collective, natural resource-, social- and health-specialist inputs. Highly recommended reading for an audience of non-health specialists, such as managers of NRM projects, researchers and recipients of development aid. It contains a well-stocked bibliography on urban-health research. (WB - from executive summary)
http://www.liv.ac.uk/~mhb/publicat/Periurban/Start.html or
http://csdinfo2.liv.ac.uk/~mhb/

HEALTH AND ENVIRONMENT AND THE URBAN POOR

Hardoy Jorge E & Satterthwaite David. 1997. In: Shahi GS, Levy BS & Kjellström T (eds), International Perspectives on Environment, Development and Health; Towards a Sustainable World (New York: Springer Publishing Company Inc.), pp 123-162.

This paper looks at an array of health problems associated with urban environments in the South. The authors draw attention to the geography of inequality regarding human and environmental health, which have differential impacts. The authors argue that the people most vulnerable to environmental hazards are those least able to avoid them. Of particular interest for urban agriculture is the focus on chemical and industrial pollutants in urban areas. The authors mark chemical pollutants as one of the four most pressing urban environmental concerns. They claim that reports from Third World cities, of severe health problems arising from human contact with toxic or hazardous wastes are increasingly common. (From Kathleen Flynn, KF - IRDC-CFP Report no. 30)

URBAN FOOD, HEALTH, AND THE ENVIRONMENT: THE CASE OF UPPER SILESIA, POLAND

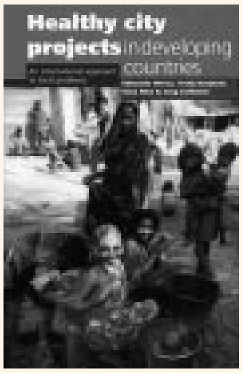
Bellows Anne C. 1999. In: Koc M, MacRae R, Mougeot L & Welsh J (eds.), For Hunger Proof Cities; Sustainable Urban Food Systems (Ottawa: International Development Research Centre), pp 132-135.

Allotment gardening is typically conducted by women, retirees, and other reserve labour. This local production has provided a measure of shelter from the vagaries of inefficient production and food distribution (that was so typical of former-centralised socialist states) and from inaccessibly high food prices, compounded by unemployment (typical of market systems). However, the yields and safety of local food labour can be reduced in severely polluted regions. In 1997, Poland celebrated 100 years of urban allotment agriculture, which has buffered local publics from alternating problems of food supply and food costs. However, the yields and safety of local food labour are sometimes sabotaged in regions burdened with severe pollution. The case study from Gliwice, in Upper Silesia, southwest Poland, discusses (1) organising an acquisition, labelling, and distribution system for retailing chemically tested organic products, linking farmers to consumers; (2) distributing chemically tested produce directly to schools and hospitals and creating subsidies for their purchase; and (3) educating community groups about food contamination and the benefits of organic and farming. (Abstract adapted from original)

TRENDS, PRIORITIES AND POLICY DIRECTIONS IN THE CONTROL OF VECTOR-BORNE DISEASES IN URBAN ENVIRONMENTS

Lines J, Harpham T, Leake C & Schofield C. Health Policy and Planning 9(2): 113-129.

This review describes how the physical and social changes associated with urbanisation have altered the transmission of vector-borne diseases. It concentrates on the important mosquito-borne infections: malaria, dengue and filariasis. Dengue virus vectors breed in relatively clean water in man-made containers, while urban filariasis vectors breed in highly polluted water, and these mosquitoes have now been spread by human activity to almost every tropical city. The authors point out that, with important exceptions, anopheline malaria vectors have not generally succeeded in adapting to urban life, but malaria can still be a problem where there are rural pockets in the middle of town. They specifically cite African cities as an area of potential risk because they tend to be relatively open, with patches of abandoned land and cultivation close to the centre. (Jo Lines)



HEALTHY CITY PROJECTS IN DEVELOPING COUNTRIES : AN INTERNATIONAL APPROACH TO LOCAL PROBLEMS

Werna E, Harpham T, Blue I, Goldstein G. 1998. London: Earthscan Publications UK. ISBN 1 85383 455 6 (pbk) 148 pp. (GBP 15.95)

This book analyses the state of the Healthy City Projects in developing countries, implemented by the World Health Organization (WHO). A holistic approach to public health care was developed based on the idea that living and environmental conditions are responsible for health, a particularly acute topic in cities where people live and work together in such close proximity. Originally established in 11 European cities, then spreading throughout Europe and further to other regions of the world, the project was, at the time of publication active in at least 1,000 cities of towns. A Healthy City project supports city health authorities and/or local government in the field of information and analysis, in particular monitoring of the health status and the analysis of requirements. A number of case studies are presented. Much attention is paid to rapid appraisal techniques and to priority-setting procedures. The book ends with an examination of factors influencing the transformation of a project cycle into a continuous process. Illustrations are scarce, but there are many boxes focusing on case studies. (WB)

NEW PUBLICATIONS

AGRICULTURE PÉRIURBAINE EN AFRIQUE SUBSAHARIENNE

Moustier P, Mbaye A, De Bon H, Guérin H & Pages J (eds). 1999. Actes de l'atelier international 20-24 avril 1998, Montpellier, France. CIRAD, CORAF.
These are conference proceedings, providing a state-of-the-art overview of periurban agriculture and horticulture in sub-Saharan Africa. This important publication highlights the wide array of agricultural activities in and around cities in Africa and the crucial place these activities occupy in the informal economy of African states. After a general introduction defining periurban agriculture and setting its limits, numerous case studies are presented, grouped according to ecozone (humid tropical and soudano-sahelian). (WB)

THE ROLE OF URBAN AND PERIURBAN AGRICULTURE IN METROPOLITAN CITY MANAGEMENT IN THE DEVELOPING COUNTRIES: A CASE STUDY OF DELHI

National Institute of Urban Affairs. 2000. Research Study Series No. 74. New Delhi: NIUA.http://www.niua.org/publicationlist/index.html (Rs. 250; US$20).
This study developed from earlier collaboration under the British DFID project on policy implications of air pollution on urban and periurban areas in developing countries. Its main concern is the contribution of urban agriculture to the national capital area of Delhi in India. After a general discussion of urban agriculture, there is a review of the policy orientation and planning provisions of the Government of India that impinge on urban agricultural practices. The case study of Delhi is described as a 'cursory review.' It gives a considerable amount of information about Delhi from official sources, and the characteristics of the periurban area or rural-urban fringe. The study tries to understand the concept and characteristics of urban agriculture, it reviews the policies that might influence such developments, studies the importance given to urban agriculture in both city development and urban environmental management and estimates its potential role in sustainable urban development. Among the conclusions: urban agriculture is important but there is no clear responsibility for these varied activities in the capital area, and planning does not yet address the issue from the standpoint of the urban poor. (C. Furedy)

WASTE COMPOSTING FOR URBAN AND PERI-URBAN AGRICULTURE: CLOSING THE RURAL - URBAN NUTRIENT CYCLE IN SUB-SAHARAN AFRICA

Drechsel P & Kunze D (eds). 2001. Co-published by CABI, UK, the International Board for Soil Research and Management (IBSRAM) and the Food and Agriculture Organization (FAO) of the United Nations. ISBN 0 85199 548 9. approx. 200 pages.
Rapid urbanisation has created a major challenge with regard to waste management and environmental protection. However, the problem can be improved by turning organic waste into compost for use as an agricultural fertiliser in (peri)urban areas. The forthcoming (May/June 2001) CABI hardcover book provides an African perspective on potentials and constraints of urban waste recycling for soil amelioration (and integrated pest management), as well as on urban and periurban farming systems as beneficiaries. Most of the papers in this publication stem from an IBSRAM - FAO workshop held in Ghana in August 1999, with authors from several European as well as African countries, representing various disciplines. Subjects in this book include: the potential use of waste-stream products for soil amelioration; economic, sociocultural and environmental considerations; turning urban waste into fertiliser; modelling urban and periurban biomass and nutrient flows; international support and capacity building in Africa. (Pay Drechsel)

THE PERI-URBAN INTERFACE, A TALE OF TWO CITIES

Brook RM & Dávila JD (eds). 2000. London: School of Agricultural and Forest Sciences, University of Wales and Developing Planning Unit, University College London. 251 pp.
This publication is written in the framework of research conducted by the Natural Resource Systems Programme of the UK Department for International Development (DFID) on natural resources in the 'peri-urban interface'. It describes research conducted in two city-regions: Kumasi, Ghana, and Hubli-Dharwad, India - both medium-sized cities and well known in the world of urban agriculture.
In six chapters, the nature of the periurban interfaces of the two cities is described. In a historical overview, the spatial and institutional setting is explained, after which an exhaustive comparison is made between the national development of India and Ghana, and between the two cities. Spatial, human and economic developments are described, but also the institutional framework under which the periurban interface has developed in recent years, as well as the decision-making processes that are likely to shape the future of the interface. The resource base of the two cities is examined considering cropping and livestock systems, and soil, water and waste management, and how the urbanisation process has affected these.
A most interesting and well-documented chapter is the discussion on the livelihood strategies of poor households, in which the sustainable-livelihoods framework dominates. Although the use of this framework does not lead to clear conclusions, and appears difficult at the (macro-) institutional level (as is acknowledged: "the framework was not at the base of the research programme"), the authors manage to capture the dynamics of livelihoods in periurban areas. Geographical Information Systems (GIS) also play an important role in the research conducted by the NRS programme and receive much attention in this publication. In a final chapter, the strength of this tool for planning and analysis in a rapidly changing environment is clearly demonstrated, notably for the case of Kumasi. (WB)

DIE WIEDERKEHR DER GAERTEN: KLEINLANDWIRTSCHAFT IM ZEITALTER DER GLOBALISIERUNG

(The return of the gardens : small-scale agriculture in the era of globalisation) Meyer-Renschhausen E & Holl A

(eds). 2000. Innsbruck : Studien-Verlag. ISBN 3 7065 1534 2. 229 pp. (in German)
City dwellers become increasingly involved in producing vegetables and fruit, rather than consuming commercially produced food. The reasons strongly vary, however, from sheer necessity in many Eastern European and developing countries, to a reaction against unhealthy commercial products, and the benefits of a relaxed pastime for urban citizens suffering from high stress. A number of chapters in this book were originally presented at the International Symposium on Urban Agriculture and Horticulture: the Linkage with Urban Planning, held in Berlin in July 2000. Cases described are from Western Europe - Germany in particular, Eastern Europe, the USA and from developing countries. Many different aspects are described, ranging from the land use issues that never fail to come up in these cases, to community development and descriptions of gardening systems, like the chinampas near Mexico City. Interestingly, a number of projects are analysed that were unsuccessful in involving the beneficiaries. Invariably, these projects did not take traditional production and consumption patterns enough into account. This is an important warning not to automatically paint a rosy picture of urban gardening. (WB)

GOOD GOVERNANCE AND URBAN DEVELOPMENT IN NAIROBI

Lee Smith D & Lamba D. 1998. Nairobi: Mazingira Institute, Kenya.
This 40-page booklet, which is a study for the background report of the World Report on the Urban Future 21, gives a good historical overview and description of the development of Nairobi and its governance. It puts the situation of agriculture in its wider context of urban planning and policy-making, forcing urban agriculturists to look at the institutional structure and governance of the city, and to perhaps understand the problems planners might face. (RvV)

URBAN AGRICULTURE & MICROFARMING, ISSUE 01, JANUARY/FEBRUARY 2001

This is the first issue of the magazine, published by TUAN Western Pacific and edited by its executive director, Geoff Wilson. The first issues are available as free inserts in "Practical Hydroponics and Greenhouses". The Magazine seems to be geared towards practicality, focusing on those practising, or interested to start, agriculture in a confined urban space and having a clear business orientation. The first issue features Singapore as an example of a city with well-advanced urban agriculture. (RvV)

Books

Websites

http://www.lboro.ac.uk/well/ This site, on Water and Environmental Health, is managed by the London School of Hygiene & Tropical Medicine and the Water, Engineering and Development Centre, Loughborough University, and further supported by a network of collaborating institutions. WELL is a resource centre promoting environmental health and well-being in developing and transitional countries.

http://csdinfo2.liv.ac.uk/~mhb/ This site, on Health Impact Assessment, is maintained by Martin Birley, and is a combined initiative of the International Centre for Health Impact Assessment of the Liverpool School of Tropical Medicine and the UK Department of Health. It has a UK focus, but has weblinks to HIA sources from other countries. It has some downloadable texts and is a good source for those looking for more information on the subject.

http://www.liv.ac.uk/~mhb/publicat/hmsocov.html At this site, you can download the book 'Health Impact Assessment of Development Projects' by MH Birley (1995).

http://www.fao.org/waicent/faoinfo/agricult/ags/agsm/sada/asia/index.htm The report and papers of the regional seminar on Feeding Asian Cities, held in Bangkok on 27-30 November 2000, can be found here. This seminar was organised by the FAO, the Association of Food Marketing Agencies (AFMA), and CITYNET, in collaboration with the International Union of Local Authorities (IULA).

http://www.who.int/ This is the homepage of the World Health Organization, with the full list of WHO publications available at *http://www.who. int/dsa/cat97/ztrs.htm* (for instance the often quoted in this issue #778 Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture, 1989). It further provides a good overview on other health-related topics.

http://puvep.webjump.com This site is home to the Urban and Periurban Small and Medium-Sized Enterprise Development for Sustainable Vegetable Production and Marketing Systems (PUVeP). It contains summarised information on a research project on periurban vegetable production, consumption and marketing in Cagayan de Oro (Philippines), Ho Chi Minh City (Vietnam) and Vientiane (Laos).

http://www.ias.unu.edu/proceedings/icibs/ibs/ibsnet/ The Integrated Bio-Systems Network is a "network of people, connected via Internet, for forum and co-operation in the applications of integrated bio-systems in agriculture, industry, forestry and habitat." This "News-Portal" type of website is managed by UNESCO's Microbial Resources Centre in Stockholm.

http://www.worldbank.org/html/fpd/urban/solid_wm/swm_body.htm#support The Urban Waste Management Thematic Group of the World Bank site gives references to publications, and short discussions on topics like institutional arrangements, private sector participation and environmental management.

http://www.gdrc.org/uem/ This site, called Urban Environmental Management, is maintained by the Global Development Research Centre. A comprehensive site, which includes names of mailing lists related to urban development, references, an agenda of events, networks, links and statistics. Related to this issue of the magazine are waste and water management, and impact assessments.

http://habitat.aq.upm.es/boletin The Spanish habitat site including the virtual library "Cities for a Sustainable Future" (*Ciudades para un futuro más sostenible*)

WORKSHOP ON RESEARCH METHODOLOGIES USED IN URBAN AGRICULTURE

December 6 and 7 2000, Dakar, Senegal

The workshop was organised by the IAGU (l'Institut Africain de Gestion Urbaine) and RFAU/ AOC, and financed by IDRC. NGO's from seven countries participated; Benin, Burkina Faso, Ivory Coast, Mali, Mauritania, Niger, and Senegal.The objective of the workshop was to exchange information on research methodologies used in urban agriculture and assess their applicability.
Information can be obtained with IAGU, Tel: +221 824 44 24; Fax: +221 825 08 26; e-mail : iagurrps@enda.sn

POLITICAL ECONOMY OF URBAN AGRICULTURE

Bronte Hotel, Harare, Zimbabwe, February 28 - March 2, 2001

This event was organised by the Municipal Development Programme for Eastern and Southern Africa (MDP-ESA) in collaboration with the IDRC. The purpose of the workshop was to get insight into the priorities in Eastern and Southern Africa on the political economy of urban agriculture.
Understanding these processes can assist in establishing political processes and institutions, which enable stakeholders to resolve potential conflicts over access to resources.
More information:
Mr Shingirayi Mushamba, Tel: +263.4.724356/774385; Fax: +263.4.774387; e-mail: region@mdpesa.co.zw ; website: www.mdpesa.co.zw

INFORMAL PERIURBAN IRRIGATION: OPPORTUNITIES AND CONSTRAINTS

Kwame Nkrumah University of Science & Technology, Kumasi, Ghana, 7-9 March, 2001

This workshop aimed to provide a forum to share observations, field experiences and findings from research into irrigated agriculture in urban and periurban settings. The focus of the workshop was to understand the extent and importance of irrigation as providing a viable livelihood within urban and periurban environments. The question of potential health risks associated with water quality and what actions might be taken was also raised. For more details, contact: Prof. Kasim Kasanga, Institute of Land Management & Development, UST, Kumasi (51 60454) or Gez Cornish, HR Wallingford, UK, Fax + 44 (0)1491 826352, e-mail: g.cornish@hrwallingford.co.uk

SECOND INTERNATIONAL COURSE ON HYDROPONICS

Toluca, Estado de México, 26-28 April, 2001

More information on this event can be found at http: //www.hidroponia.org.mx (in Spanish)

TENTH INTERNATIONAL CONFERENCE OF THE ASSOCIATION OF INSTITUTIONS FOR TROPICAL VETERINARY MEDICINE (AITVM)

Copenhagen, Denmark, August 20-24, 2001

The AITVM aims at an improvement of human health and quality of life by means of increased and safe food production in tropical regions, through the enhancement of research, training and education in veterinary medicine and livestock production, within the framework of sustainable development. The 10th International Conference will address the theme: "Livestock, Community and Environment". The workshops will cover topics such as: livestock-environment interactions and their impact on human health and animal health/reproduction; periurban animal production systems - opportunities and environmental constraints; and veterinary public health: aspects of zoonoses and food quality.
More information on registration can be found at www.aitvm.org.
AITVM Conference Secretariat: The Danish Centre for Experimental Parasitology

CGIAR SYSTEM-WIDE INITIATIVE ON MALARIA AND AGRICULTURE (SIMA) A CALL FOR RESEARCH PARTNERS

The International Water Management Institute (IWMI) co-ordinates the CGIAR System-wide Initiative on Malaria and Agriculture (SIMA). The basis for the initiative is the need to better understand the important links that exist between agriculture and malaria, a disease that has been responsible for untold human suffering, especially in Africa. As a first step in the exploratory process for SIMA, IWMI researchers in the Health and Environment Programme developed a summary of highlights on the links between malaria and agriculture. The target audience includes national and international research institutions, universities, non-governmental organisations, communities in malaria-prone areas, the private sector and donor organisations. A first key stakeholder-planning meeting will be held in April 2001, in Nairobi, Kenya, in order to constitute a steering committee for SIMA, to discuss available knowledge on the links between malaria and agriculture, to review current or proposed research related to malaria and agriculture, to determine research directions and needs, and to propose partnerships to address these needs.
In preparation for the April 2001 SIMA consultation, an e-discussion has been initiated to facilitate dialogue among a wide audience. The e-discussion will run until 15 March 2001, when various contributions will be synthesised and compiled into a report to be discussed during the April meeting in Nairobi.
SIMA Co-ordinator: Dr. Clifford Mutero, International Water Management Institute (IWMI), C/o ICRAF, Nairobi, e-mail c.mutero@cgiar.org

FORTHCOMING EVENTS

Royal Veterinary and Agricultural University, Ridebanevej 3, DK-1870 Frederiksberg Denmark; Phone: +45 35282785; Fax: +45 35282774.

LATIN AMERICAN RESEARCH NETWORK ON URBAN AGRICULTURE: RED AGUILA

AGUILA is a network of Latin American and Caribbean institutes and organisations working on urban agriculture. It was founded in 1995 in La Paz, Bolivia, and currently counts more than 45 members from 18 countries. The mission of AGUILA is to unite and articulate the activities of its members by means of research, communication and information exchange, training and co-operation. Its activities comprise:

- translation of the Urban Agriculture Magazine into Spanish;
- setting up of and maintenance of databases and a website;
- publication of two-monthly electronic Bulletins;
- implementation of several regional projects on Urban Agriculture; and
- organisation of regional events for exchanges. Since January 2001, the Secretariat of AGUILA is managed by the Institute for Promotion of Social economy (IPES), located in Lima, Peru. IPES/AGUILA and the Urban Management Programme for Latin America and the Caribbean (UMP-LAC/UNCHS-HABITAT/-UNDP) and its City Working Group on Urban Agriculture (see Magazine no. 1) serve as the Regional Focal point for RUAF. For further information, e-mail: aguila@ipes.org.pe

FOURTH MEETING ON ORGANIC AGRICULTURE

Havana, Cuba, 17-19 May, 2001

This meeting is being organised by ACTAF (*Asociación Cubana de Técnicos Agrícolas y Forestales*) and the Organic Agriculture Group of Cuba. The main objective of this meeting is to discuss progress made on organic agriculture in rural and urban areas. Among the main themes for discussion is urban agriculture. Information can be obtained from the *Secretario Ejecutivo IV Encuentro de Agricultura Orgánica*. ACTAF, Ciudad de la Habana, Cuba. Telephone +.537.845266 Fax: +.537.845387; E-mail: actaf@minag.gov.cu

AGROPOLIS IN THREE LANGUAGES

Agropolis is the research and training awards programme, co-ordinated and led by the IDRC on behalf of the Support Group on Urban Agriculture (SGUA). Agropolis supports innovative Masters' and Doctoral research in urban agriculture around the world. Each award covers field research expenses of up to CA$ 20,000 for the period of the research (between 3 and 12 months).

The deadline for applying for 2002 awards is December 31, 2001.

Agropolis now has its own homepage in three languages. Please link to:
http://www.idrc.ca/cfp/agrhome.html for English
http://www.idrc.ca/cfp/fagrhome.html for French
http://www.idrc.ca/cfp/sagrhome.html for Spanish

THE AGRICULTURE-URBANISATION INTERFACE IN COASTAL LEBANON AND IN THE MIDDLE EAST/NORTH AFRICA

The French Cultural Centre of Beirut, Beirut, Lebanon, 13-16 June, 2001

This will be a combined event, in which the results of a four-year running research programme will be presented and discussed, after which a regional needs assessment will be held (to start up the regional RUAF Programme in the Middle East). The four-year research program (currently in its final year) has been established in order to study the agriculture-urbanisation relationship to suggest possible changes in both urban and agricultural policies, to enhance the capacity of the agricultural sector to survive and prosper in an increasingly urbanised Lebanon. A number of studies and discussions among researchers and stakeholders have been undertaken. The programme was also meant as a foundation for broader regional exchanges, which would cover neighbouring countries in the southern and eastern Mediterranean basin. The coastal Lebanon programme and the regional needs assessment is co-ordinated by Joe Nasr, vice-president of The Urban Agriculture Network (TUAN) and researcher at the CERMOC. CERMOC is also the main host. The Lebanon program is inscribed within the activities of the CERMOC's Observatoire de Recherches sur Beyrouth et la Reconstruction.
For further information, you can contact: Joe Nasr, e-mail: joenasr@compuserve.com

REGIONAL TRAINING COURSE ON URBAN AGRICULTURE

The "Cities Feeding People Programme" of the International Development and Research Centre (IDRC-Canada) is collaborating with UMP-LAC/UNCHS-Habitat and its anchoring institute IPES in the development and implementation of the first Regional Training Course on Urban Agriculture. Specific support to the project will also be provided by ETC-RUAF, NRI-UK and the FAO. The course will be held in November in Quito-Ecuador, and will allow twenty (20) municipal staff members, researchers, NGO professionals, and representatives of producer or marketing organisations to discuss and evaluate together proposals for action-research and concrete intervention in urban agriculture, so as to influence planning and management of their cities. The project foresees the development and production of six training manuals, and an interactive CD- ROM. More information: Marielle Dubbeling, Urban Management Programme for Latin America and the Caribbean (UMP-LAC/IPES). E-mail: marid@pgu.ecuanex.net.ec

SUSTAINABLE FOOD SECURITY FOR ALL BY 2020: FROM DIALOGUE TO ACTION

International Congress Centre of the Federal Parliament, Bonn, Germany, September 4-6, 2001

The International Food Policy Research Institute (IFPRI) will, in close collaboration with the German Federal Ministry for Economic Co-operation and Development (BMZ), organise this event.
The conference takes stock of the current situation, reviews progress in achieving sustainable food security since the first 2020 Vision conference in 1995, and offers state-of-the-art projections for scenarios in 2020. The Congress will focus on the emerging issues that are most likely to affect the global goal of achieving sustainable food security for all by the year 2020, and to prioritise actions. For more information and registration: www.ifpri.org/2020conference

Call for contributions

In the forthcoming issue no. 4 of the Urban Agriculture Magazine, we would like to focus on practical experiences of integrating urban and periurban agriculture into city development and urban landuse planning. We explicitly invite local stakeholders like municipal politicians, urban planners, farmer associations, urban NGOs and sectoral organisations to share their practical experiences in integrating agriculture into urban planning and the lessons learned.

You are requested to send us your contributions before May 1, 2001.

The following questions could assist in focusing your contributions:

A. THE PROCESS OF INTEGRATION

❖ What activities have been undertaken to integrate urban agriculture in urban planning and what was the approach used? ❖ Which actors were involved in the process? How did farmer organisations and neighbourhood committees participate? Did conflicts of interest occur, and how were these managed? Was there one lead institution? ❖ What were the main results of the process (an action plan, integration of urban zonification or development plans; revised municipal by-laws and regulations, etc.)? ❖ How have these changes effected the development of UPA? ❖ What factors determined the success and failure of the integration process?

B. ACCESS TO LAND

❖ Which measures have been implemented to improve access to land and to secure the continuity of agricultural use of these areas, and what have been the results? ❖ What strategies were used (both by farmers and by the planners)? ❖ What are the gender aspects to take into account? ❖ What are the recommendations?

C. ZONIFICATION

❖ Which methodology and form of participation was followed to define the zonification? ❖ Which zoning categories were distinguished? ❖ What measures are applied to ensure adherence to the zonification established? ❖ What is the rate of success of these measures and what factors played a role? ❖ What improvements are suggested?

No. 5 of the Urban Agriculture Magazine will be closely linked to the workshop on 'Appropriate methodologies for urban agriculture research, planning, implementation and evaluation' that will take place in Lima (Peru) in August 2001. This issue is planned for publication in October 2001, and will contain summary papers and selected contributions of the workshop.

You are requested to send us your papers with experiences or suggestions on 'Appropriate methodologies' before May 1, 2001.

The workshop will be a meeting of 'topic co-ordinators' and other invited persons. The main topics to be dealt with can be grouped in the following way:
1) Tools and methodologies for **diagnosis** (eg participatory rapid food and nutrition assessment, GIS, PRA, rapid market analysis, agro-environmental mapping, etc.).
2) **Technology development and evaluation** (technologies designed or adapted for specific urban farming conditions, participatory technology development and assessment).
3) **Evaluation and monitoring tools** (methodologies for monitoring the impacts on food security and nutrition, health, income, employment, urban ecology; differentiated for gender and socio-economic strata).
4) A. **Landuse planning** and platform building (methodologies for the integration of UA in urban development and land-use planning);
B. Project planning and implementation.
5) **Policy tools** (participatory and 'early implementation' approaches to policy formulation; stakeholder analysis; integration of urban agriculture in sectoral programmes; public-private partnerships).
6) **Enterprise development** (innovative approaches in input supply, marketing, food processing and distribution and consumer-producer relations).

Contributions

We would like to receive articles of up to 2,500 words long, preferably accompanied by illustrations (digital if possible), references and a good abstract. Descriptions of integration of agriculture in urban planning and of methodologies should be written in such a way that those working with farmers could readily understand them.

We welcome photos, and any information on recent publications and videos, information on workshops, training courses, conferences, as well as information on relevant journals, web-links, networks, etc.

Urban Agriculture Magazine

HEALTH
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