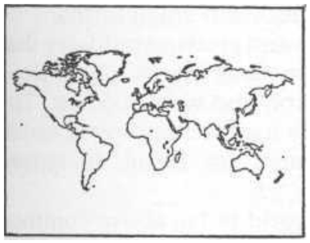

# Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources

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## I. INTRODUCTION

**THIS PAPER DESCRIBES** how cities can be transformed from being only consumers of food and other agricultural products into important resource-conserving, health-improving, sustainable generators of these products. In particular, agriculture in towns, cities and metropolitan areas can convert urban wastes into resources, put vacant and under-utilized areas into productive use, and conserve natural resources outside cities while improving the environment for urban living. Agriculture within urban and peri-urban areas is defined as a common and beneficial land use. This paper also gives examples of urban agriculture programmes which help alleviate poverty while creating these benefits.

## II. THE SCALE AND SCOPE OF URBAN AGRICULTURE

**THIS PAPER ARGUES** that sustainable cities require an economic process to close the open loop system where consumables are imported into the urban areas and their remainders and packaging dumped as waste into the bioregion and biosphere. Thus, the "through-put" of resources by towns and cities needs to be reduced.

The urban agriculture referred to in this paper is food and fuel grown within the daily rhythm of the city or town, produced directly for the market and frequently processed and marketed by the farmers or their close associates. It includes:

- aquaculture in tanks, ponds, rivers and coastal bays;
- livestock (particularly micro-livestock) raised in backyards, along roadsides, within utility rights-of-way, in poultry sheds and piggeries;
- orchards, including vineyards, street trees, and backyard trees; and
- vegetables and other crops grown on roof tops, in backyards, in vacant lots of industrial estates, along canals, on the grounds of

institutions, on roadsides and in many suburban small farms.

Urban agriculture is presented as a large and growing industry that uses urban waste water and urban solid waste as inputs which close ecological loops when processed on idle land and water bodies. The positive impacts of this neglected industry include: improved nutrition and health, an improved environment for living, increased entrepreneurship, and improved equity.

The scale of urban agriculture in the world is far above common perceptions. In Kenya and Tanzania, two out of three urban families are engaged in fanning.[1] Some full-time as entrepreneurs or wage earners and more as a part-time household activity. In Taiwan over half of all urban families are members of farming associations. Large Chinese cities produce 90 per cent and more of their vegetable requirement within their urban regions. In America one-third of the agricultural product (in dollar terms) is produced within metropolitan areas.[2] Japan, The Netherlands, and Chile are other examples of countries where there are more urban than rural farmers.

1. Mazingira Institute (1987), *Urban Food Production,* Nairobi. See in particular Part 3 - section "Problems", pages 166-170 and tables 3.95 to 3.97.

2. Heimlich, Ralph E. (1989), *Land Use Transition in Urbanizing Areas,* proceedings of a workshop, ERS/USDSA, Washington DC.

The benefits of urban agriculture vary with time and place. It is often a first line of defence against hunger and malnutrition at times of particular stress, as in Kinshasa and Lima at the time of this writing. It is a major process of poverty alleviation during periods of economic recovery, as seen during recent visits to Lusaka and Dar-es-Salaam. It improves the quality of the urban environment through greening and a reduction in pollution, beginning in the low-income neighbourhoods (where the greatest needs lie). It strengthens the economic base of a city or town by adding an "import substitution" industry that includes production, processing, packaging and marketing. It does this primarily through small enterprises, although medium and large operations are also involved. Finally, urban agriculture, by closing open loops and reducing the through-put of resources in cities and towns, makes a large contribution to balancing the global ecology.

In keeping with the theme of this issue of *Environment and Urbanization,* the core of this paper will focus on the resource aspect of urban agriculture. The relationship between urban agriculture and resources can be described as being three-pronged. First, some urban by-products, such as waste water and organic solid waste, can be recycled and transformed into resources or opportunities for growing agricultural products within urban and peri-urban areas. Second, some areas of cities, such as idle lands and bodies of water, can be converted to intensive agricultural production. Third, some other natural resources, such as energy for transportation and cooling, can be conserved through urban agriculture.[3]

3. Sachs, I. and D. Silk (1990), *Food and Energy,* (UNU-FEN) UNU Press, Paris. Chapter 5 summarizes the benefits and problems of Urban Agriculture.

The primary evidence for this study was assembled during visits to cities in 18 countries in Asia, Africa and Latin America during the past year. Support has poured in from many sources, from farmers in the field to prestigious centres of learning. A monograph is in draft form and will be published early in 1993. The project is continuing with research and pilot projects.

## III. URBAN WASTES AS RESOURCES

**WITH THE RAPIDLY** growing metropolitan areas in Third World countries comes a concomitant growth in a variety of by-products of urban life. One of the principal limits to the sustainability of towns and cities is the disposal of some of these by-products, namely waste water and solid waste. Simply put, mega-cities of both the Third and the First Worlds, as well as smaller cities everywhere, are having increasing difficulty dealing with the problems of solid and liquid wastes.

A paradigmatic change in the way wastes are viewed may be starting to emerge globally, and it is important for this change to continue and to be accelerated. Wastes (with exceptions) need to be seen not as a problem to be disposed of, but as a resource for sustainable development. A vision of metropolitan areas is evolving from primarily **open loop** systems with one-way flows of resources (in) and wastes (out), to primarily **closed loop systems** where the definition of wastes and resources becomes blurred. In other words, cities can become more **resourceful** in both the literal and the figurative senses. Urban agriculture is a clear and significant example of this possibility of converting the consume-dispose open loops into consume-process-reuse closed loops.

One of the most significant imports into urbanized areas is food. At the same time, cities export daily a vast volume of wastes to be disposed of in their bioregion or in adjacent regions, with low-income cities having a much higher share of total waste as organic and food wastes. Historically, these wastes have been inputs into the production of a city's food, and they can again become so. Converting food waste into fresh food reduces food costs, improves the quality of food available, improves the environment for living, creates jobs and reduces municipal management costs.

The reuse of urban waste, particularly metal, glass and paper, is already an established practice in even the most wasteful cities in Europe, Japan and North America, as is the recycling of a wider variety of products in Third World countries. The recycling of organic wastes, particularly in Third World countries, may be more significant to the ecology of urban bioregions because nutrient and pathogen pollution of the ecology are damaging to the health of the population and reduce the capacity of the environment to sustain future generations.(4) Urban agriculture can play an especially significant role in the recycling of organic wastes. These wastes can be divided into two categories: waste water and solid waste.

4. Obeng, Letitia, A. and F. W. Wright (1987), *The Co-composting of Domestic Solid and Human Wastes,* World Bank Technical Paper No. 57, Washington DC. Chapter 3 presents systems for control of pathogens. Chapter 6 covers economic feasibility.

### a. Waste Water

In cities of the arid and semi-arid regions, the availability of water for household use is limited. Water for irrigation is even less available. Thus, nutrient-rich waste water provides a precious agricultural input. Its value increases with a decreasing income level, as the potential user has less capacity to pay for organic and chemical fertilizers. Its value is also enhanced as it is available close to markets.

Waste water can substitute for freshwater, which then increases the availability of freshwater for drinking, cooking and other uses. It is self-evident that the urban areas produce great amounts of waste water of human origin, in direct proportion to their population. It therefore makes special sense to use it for irrigation of land and aquatic crops within metropolitan areas and adjacent to towns.

A number of cities in Third World countries already use this resource wisely. It has been estimated that one-tenth or more of the world's population currently eats food produced on waste water.(5) Mexico City pumps over half of its sewage 50 miles and more to the north, where it is used to irrigate over 100,000 hectares for livestock

5. Lunven, Paul (1992), presentation at Urban Nutrition Conference, Mexico City, February, unpublished.

feed. One hundred other cities in Mexico use similar systems. Calcutta produces one-third of its fish in sewage-fed lagoons and a similar share of its vegetables from waste water irrigation.(6)

6. Ghosh, D. (1990), "Wastewater-fed aquaculture in the wetlands of Calcutta: an overview" in *Wastewater-fed Aquaculture,* AIT & ICLARM, Bangkok.

Cities from China to California convert waste water safely into food. However, for each city that does so safely, the formal and informal sectors in many more cities are allowed to operate without monitoring or are directly engaged in practices that spread disease through improper use.

Some obstacles confront the utilization of waste water in urban agriculture. First, the use of wastes as agricultural inputs is more feasible in the urban areas of Third World countries than in those of industrial ones, as their wastes contain less chemicals and toxic materials. Careful monitoring is clearly necessary for such usage, and some cities in the Third World have built up sizable industries over the past few decades. Still, even areas of heavy industry can contribute to urban agriculture. A good illustration is the Camacari petrochemical complex in eastern Brazil, where the sludge recovered from the factories is used to improve the soils of nearby agricultural areas.(7)

7. Catao Aguiar, Sergio and Jaire Jose Farias (1986), "Food and energy from industrial wastes", *UNU Work in Progress,* Vol. 10, No. 1, page 3.

A more serious obstacle to the use of municipal effluent as an input to food production in Third World countries is the presence of pathogens and vectors. Fortunately, this problem is readily manageable. Pathogens can be removed using two approaches. First, the waste water can be biologically treated to remove the pathogens sufficiently so that it can be safely used for irrigation and as a medium for raising fish and other aquatic crops. Low-capital intensive processes for eliminating pathogens and vectors exist. These commonly use: sunlight, time and an intermediate plant or animal such as algae or duckweed which is then used as organic fertilizer or animal feed.(8)

8. Shuval, H. I. et al. (1986), *Wastewater Irrigation in Developing Countries,* World Bank Technical Paper No. 51, Washington DC, (chapter 5 discusses treatment for pathogens); and US Environmental Protection Agency (1981), *Land Application of Municipal Sewage and Sludge for the Production of Fruits and Vegetables* EPA, Washington DC, (this document sets up policy and guidance on procedures for pathogens, lead and PCB treatment and has an appendix on crop selection).

The second approach to managing the problem of pathogens focuses on the crop that is grown using waste water as an input, rather than the waste water. The susceptibility of crops to contamination varies. Some plants or animals absorb, retain and transmit pathogens more than others. At the simplest, fruit at the end of a branch transmits fewer pathogens than a leaf crop such as lettuce. Crops that are used as feed or inputs in the production of further crops are an extra step removed from human consumption and therefore usually safer.(9) The Mexico City system is an inefficient but effective example. Finally, many cities use waste water to grow forest crops for fuel, construction materials and improvement of the environment, ie. non-food crops.

9. Bartone, Carl R., et al. (1985), *Monitoring and Maintenance of Treated Water Quality in the San Juan Lagoons,* PAHO/WHO/CEPIS, Lima. The introduction and table 1 present an overview of the issue and its resolution.

The most subtle and challenging hurdle to cross in the use of urban waste water for human food consumption may be "culture". In a number of cultures, irrigation with "soiled water" is taboo. The first reaction to the concept is often an immediate "But, it is not safe!". The idea of properly "disposing of waste water dates back to the "microbe hunters" of the late nineteenth century. This view, deeply ingrained in the "modern" psyche, is communicated to many newly modernizing cultures.

Fear of contamination by unclean water has, over time, become institutionalized in law and in a reluctance by many governments and bureaucracies to move beyond this black-and-white view of water. Professional city managers and planners are concerned traditionally with public health and infrastructural efficiency; until the 1990s, they have generally been little concerned with the efficient reuse of waste to achieve ecologically sustainable towns and cities. Rather, they have

10. Jorge Hardoy defines this point as the critical barrier to urban agriculture achieving its full potential, in a personal communication in Argentina, March 1992. See also Meier, Richard, L. (1988), *Ecological Planning and Design,* Working Paper, University of California at Berkeley, CEPR-WP-02-88 and Declan, Kennedy (1990), "Urban perma-culture" in Canfield, C. (editor), *Eco-city Conference,* Urban Ecology, Berkeley, CA. (chapter 4 presents eco-city theory).

tended to act as the enforcers of cultural values rooted in history rather than on today's problems and the ecological discoveries of the post-World War II period.(10)

Western cultural attitudes are not the only cultural barriers. Obstacles also exist among traditional cultures. Some of these obstacles are religious. In Muslim countries, for example, there is usually particular reticence to using waste water for aquaculture and irrigating crops. As the Middle East runs out of fresh water, it may need to be in the front-line of waste water agricultural research.

Some choices have to be made in the implementation of waste water reuse in urban agriculture. Where and when is it appropriate? At what scale is it best introduced? What might be the process in new and established cities? Choice, which is perforce political, must give local weight to at least the following: the cultural acceptability (less efficient processes may be called for in some cities), the relative scarcity of water or reliability of the source, the current and projected condition of the environment for living and its sustainability, the health implications for the population (in cities without efficient sewer system reuse may be more urgent), and the cost of water, especially to low-income groups.

The scale of the waste water management system is technically and politically significant. While waste water systems since the middle of the nineteenth century have been based on the principles of economies of scale, modern biological technology seems to favour smaller systems. Considering energy, infrastructure and ecological impacts, neighbourhood and community systems may be both more appropriate and more efficient. This suits urban agriculture, which clearly can benefit from relatively dispersed sources of waste water for irrigation and aquaculture.

The transformation of waste water from a pollutant to an input is, in most applications, likely to be gradual rather than abrupt. The conversion from the nineteenth century "disposal system" to the twenty-first century "reuse system" may take a generation, being phased in over the useful life of the old system or according to the capacity of urban agriculture to absorb it. It can often be introduced first in with non-existant or newly developing sewage systems in portions of cities and towns. The overarching aim of the waste water management system may well include the minimization of through-put. Thus, less waste water leaving a city may indicate a better system.

One in ten of the human population currently consumes food produced by the direct use of waste water, most of it with no or incomplete treatment. Urban agriculture offers a solution to this vast health problem, when properly practised. Rural and urban wastes dumped and leached into rivers, lakes, bays/lagoons, seas and the oceans are one of the greatest degraders of our bioregions and the biosphere. Waste water aquaculture, livestock and horticultural farming systems focused on Third World urban markets can be a major tool in arresting and, in time, reversing this devastation.

### b. Solid Waste

Solid waste in most cities and towns is a significant and essential input to sustainable urban agriculture. The contributions of solid waste are best separated into the organic and inorganic. The latter's usefulness in agriculture is as a source of soil, supplies and raw materials for construction. Chemical by-products from manufacturing are useful in soil improvement. Construction debris provides the base for shaping fields and ponds. Planting containers are built from wood and plastics of all sorts, recycled and reprocessed. Tyres are used as containers. Barrels hold irrigation water. Cut plastic bottles are used to grow crops on walls and fences, and plastic bags and sheeting are used as a mulch to conserve water and retard weeds. The more significant inputs are the organic solid wastes. The leading sources of organic wastes vary from climate to climate and economy to economy. Food wastes are always near the top of the list. Some foods generate more wastes than others, eg. cabbage and green coconuts in tropical climates. In temperate climates, street trees and grass clippings are a significant source of organic waste. Some manufacturing processes such as paper production generate high levels of organic wastes. With proper concern about the lead content of some coloured inks, paper is a good mulch and soil enhancing agent.

Many of the benefits of, and the impediments to, the utilization of waste water detailed above apply somewhat to organic wastes. Thus, health and cultural considerations are applicable here also. However, the wide use of organic solid wastes is far more accepted, as the prejudices against them do not exist in the same way, and the widespread use of manure as a fertilizer has never disappeared. Composting is widely accepted as a beneficial activity and its use is expanding, albeit not always using efficient processes.

The hurdles to a wider and more efficient use of solid wastes in urban agriculture are different than for waste water. Much of the agriculture that exists within urban areas is small scale and quite dispersed. The solid waste that originates in households and businesses in many cities is collected as a large system and transported to some major dumping locations within or outside the city. This process is not very conducive to maximizing the utilization of solid waste in agriculture or regenerating the natural resources of the city. Furthermore, most solid waste management systems do not separate organic and inorganic and toxic and non-toxic wastes. Many solid wastes are also disposed of through waste water systems.

A goal for managing solid waste in urban areas should therefore be to minimize the through-put. Thus, a basic measure of the soundness of the system is the paucity of solid waste exiting the urban area or bioregion. Redesigning solid waste management from the point of view of the urban farmer and future generations may suggest sorting waste at the home or business and at the farm within or at the edge of the community. Such a system would aim to transform waste to fertile soil, green plants and food within portions of a city. It would principally collect and sort what is suitable as agricultural and landscape inputs, including composting and other modifications, before reuse.

An example is a farm in Jakarta on the property of a race track. The farmers recycle the track's wastes and those of the high-income surrounding neighbourhood. The wastes are sorted at a station within the farm. Glass, metal and cloth go to a recycling centre and organic material is composted on site. Everything moves by handcart. Thus, what goes to landfills is very limited and jobs and fresh food are generated within the community.

In addition to the system considerations, the use of organic solid waste as fertilizer has implications at the farm, household and neighbourhood levels. Thus, the urban farm, whether animal, horticultural or other, can be organized to collect and process as much of its nutrient-providing wastes as possible. The household with a backyard or a rooftop garden can be set up to reuse its own organic waste. Consequently, this is partly a technical matter and partly a matter of extension specialists showing the farmer **how** solid waste can be an input in urban agriculture.

In most urban situations, urban farmers collaborate with neighbours. Support from the municipality and major institutions is less common, and there are some legal obstacles to the retention and reuse of solid waste, especially in the more industrialized countries. However, some universities and botanical gardens have good support programmes in the Philippines, the USA, India and other countries. In conclusion, the foremost hurdles to a wider use of solid waste in urban agriculture are organizational rather than technical, sanitary or cultural as is the case with waste water.

## III. UNDER-UTILIZED URBAN LAND AND WATER SURFACES AS RESOURCES

**NOT ONLY SHOULD** the waste by-products of the urban areas be perceived and utilized as resources to be input into agricultural production within the urban domain, but the urban setting itself should also be seen as a resource to be tapped for the same productive purposes.

Cities in Third World countries are widely perceived as solidly built up with no area to spare. The use of a land area inside or at the edge of a city is seen typically as being at most an interim activity. Agriculture and urbanization are commonly viewed as conflicting activities. A closer look reveals however that there are considerable land and water areas in the urbanized sphere that are available for agricultural use. Furthermore, the agricultural use of areas at the edge of cities should not be regarded as a marginal use, but rather as an integral part of that urban area's expanding productive system. As the city grows, agriculture can grow with it, as the periphery extends and infill construction takes over farm sites.

Our studies to date indicate that nutritional self-reliance, in the sense of an urban area producing half or more of its nutritional requirements, is possible in all but the harshest climates, after consideration of land and water needs. The 1980 census found that the 18 largest urban regions in China were self-sufficient in vegetables, and some even exported some of their surplus produce to other regions. Hong Kong, one of the world's densest cities, produced 40 per cent of its fish requirements within its waters in the mid-1980s and continues to develop more efficient technologies. Two out of three urban families in Kenya farm, and access to land was mentioned there as a significant, although not major, constraint to urban farming.

Every city has a special history, economy, landscape and culture. Where urban agriculture can be established or expanded as an industry will depend on a city's special circumstances. Non-availability of land and water surfaces tends not to be a constraint to urban agriculture. The limits are more likely to be labour costs, or returns to labour, legal restrictions and land rent considerations. Legal and economic access to land and water bodies is a common problem.

All cities and towns have a number of vacant and under-utilized surfaces in urban areas that can be used for agriculture. These surfaces include those areas not suited for built-up uses, idle public and other lands, lands that can have an interim use, community lands, and household areas. The following sections describe how these can be used for urban agriculture.

### a. Areas Not Suited for Built-up Uses

The most important such areas are probably those which are not suitable for substantial building. These include steep slopes, wetlands and flood plains. For environmental reasons, the settlement of these areas is not desirable. Even if feasible, it can be costly to service. These areas are best kept as permanent open space, including cultivation.

In the case of steep slopes, forestry or terraced horticulture may be the best use of the land, stabilizing the slopes, preventing erosion, and absorbing air pollution. Mexico City, for example, is attempting to maintain, for ecological reasons, a "green belt" on its surrounding mountains. Mexico City also provides one of the best-known examples of an appropriate use of wetlands in its centuries-old *chinampas* farming system which combines, aquatic, tree, vegetable and flower production with recreation, tourism and the trading of other areas' produce.(11) The floating fish farms of Hong Kong are an example of a marine urban farming system. Finally, it is clear that intensive agriculture may be one of the only suitable economic uses for fertile but flood-prone areas anywhere.

11. Grupo de Estudios Ambientales (1986), *For la Regeneracion de Xochimilco,* GEA, Mexico City. Thishasabrief overview of the raised bed aqua/ agriculture and a projection of its future.

### b. Idle Public and Other Lands

In addition to the areas whose best use is for agriculture, there are a number of land areas in cities that are reserved in the longer-term for other uses but which incorporate vast under-utilized or unutilized tracts of land. These areas have a great potential for food production, waste-processing and other uses that enhance the environment.

As with waste water, a change in thinking is often needed to achieve this on a wide scale. If every sizable piece of land (both public and private) which is not fully developed is looked at with the question "Why is this land idle?" in mind, it would be possible to identify many potential agricultural areas. Resistance from those holding the land is often encountered, usually due to fear of loss of control. Since the agricultural use does not **have to be** permanent, these fears have to be assuaged.

The use of the legal system is crucial for institutionalizing farmers' access to idle land. The validity and enforceability of leases and contracts can determine whether arrangements for such uses will be practicable. An important legal principle here is that of usufruct, which is essentially that anyone can use land which is idle as long as the utility of the land to the owner is not diminished. Usufruct is basic in Roman law and some of its derivatives, including Italian and Spanish law. Much tribal law in Asia and Africa includes usufruct principles.

Many idle lands in cities are public or quasi-public, making their utilization for productive purposes even more imperative to serve the common good. They include land surrounding airport runways, low-density university areas, military reservations, prisons, hospitals, and parks. These frequently cover very large areas in the cities of many Third World countries.

A number of these open areas are already used for agricultural purposes. The public entities that have leases for urban agriculture in operation include an airport in Cameroon, the University of Manila, hospitals in Lima, the Presidio military base in San Francisco, and the Palace grounds in Bangkok. The case of the Jakarta race track has already been described already in the context of solid waste management.

A special case of farming on public lands is agriculture along roadsides and other rights-of-way. It is a special case for two reasons. First, the area of land and its distribution throughout the urbanized areas are usually on a far greater scale than with other idle public lands. Second, the nature of the public area has significantly different implications for the nature of the agriculture. The linearity of the land means that it can extend far outside the metropolis and still be part of its foodshed. However, it also exposes the products to particular hazards such as theft and lead poisoning from car exhausts; this means the need for a careful selection of what is grown.

The fact that such agricultural areas follow transportation lines makes them especially suitable for the most intensive and productive types of food cultivation, allowing far easier access to the market or even roadside sale. One can witness radial foodsheds outside most major cities in sub-Saharan Africa. Sao Paulo has intensive agriculture under high-voltage electrical lines. In Europe, such farming is more commonly found along nineteenth century railroads and canals.

### c. Interim Use of Land

The use of idle urban lands for agriculture does not have to be permanent *or* even *long-term. It can* be a very adequate interim use. In Durgapur, a large planned industrial city in West Bengal, the plant managers leased land that was not to be built on until later years, and provided access to the water reservoir which is used for cooling the steel, to the workers' union. The industrial city thus started to become nutritionally self-reliant.[(12)]

As a city grows, its perimeter grows more rapidly than its area. Therefore, there is always new land available temporarily at the edge of the city. As it grows, it is also always tearing down and rebuilding older neighbourhoods. Consequently, one finds temporary sites for urban agriculture near the centre. It is even possible for old factory buildings to be converted into mushroom and greenhouse agriculture.

While the lack of a secure tenure is very detrimental to a farmer, who does not know whether he or she will see the fruit of their effort, tenure that is assured for a minimum of one season can be sufficient (depending on the crop and the condition of the land) for a farmer to be willing to farm. This can be vividly illustrated by the case of Matahalib Gardens, a community garden created in an idle, rubble-strewn parcel between two shanty areas of Manila. This community garden was very successful during its first year. In the second year, however, as word spread that the parcel was to be reclaimed for development, the efforts of the gardeners dropped and the yield fell with it dramatically. Thus, the interim availability of land is sufficient for fanning, as long as it is a **secure** interim use.[(13)]

Tenure can be secured informally, or it can be formalized through a contract. Again, the idea of usufruct, fruitfully using others' land, is key in validating interim urban agriculture. A number of countries and local governments have begun to articulate this principle. Peru

12. Smit, Jac (1968), *Durgapur Structure Plan,* West Bengal Government, West Bengal, India.

13. Yeung, Yue-Man (1986), "Urban agriculture: three cities in Asia", *UNU Work in Progress,* Vol. 10, No. 1, page 7.

is urging public and private landowners to make "free land" available to farmers' associations.[14] The government of Indonesia and the municipality of Jakarta have a policy and programme of persuading public and private landowners to make "sleeping land" productive.[15] New York City has made over 1,000 vacant city owned lots available to groups of farmers.

14. HUFACAM, in the Ministry of Agriculture, was established in 1988 to promote urban agriculture in collaboration with local government and NGOs.

15. Buku Panduan (1991), paper presented at the Urban Agriculture Seminar, Jakarta, 30-31 August.

### d. Community Lands

Community gardening, along with backyard gardening, is the farming system most immediately associated with the idea of urban food production. Its contribution is clearly not negligible. It is particularly common in cultures where a long tradition of urban multicrop gardening exists.[16]

16. Wade, Isabel (1987), "Community food production", *Food and Nutrition Bulletin,* Vol. IX, No. 2, pages 29-36. This compares three community garden programmes in Asia, Africa and Latin America.

However, urban community agriculture goes beyond the community garden. Two other variants are worth mentioning. First, school gardens aim specifically at improving the nutritional status and consequently the health of school children, as well as instilling in them the techniques and habits of growing what they eat. Elementary school gardens have been, in some cultures, particularly effective in introducing urban farming to the families of the students. Second, in Latin America in particular, some of the community kitchens *(comedores populares)* increasingly have adjacent gardens to grow part of what is cooked in the kitchen and served to the members.[17]

17. School gardens have been supported in Asia and Africa by the Asian Vegetable Research and Development Centre (AVRDC), Taiwan, and in Asia and Latin America by International Institute for Rural Reconstruction (IIRR), Philippines. *Comedores* gardens are being supported by CARE, Peru and HUFACAM, Peru and others.

### e. Household Surfaces

As with community lands, there are more surfaces in the household where food can be grown than the backyard. The potential for using rooftops, balconies and the like for growing vegetables and micro-livestock for consumption and sale is largely untapped. Field visits to some homes provides a real eye-opening experience as to how resourcefully home surfaces, even in apartments, can be used. The range of what is produced in homes also goes beyond just vegetables and fruit trees. For instance, medicinal herbs on rooftops in Santiago, silkworms on balconies in old Delhi, pigeons in downtown Cairo, rabbits in Mexico City's illegal settlements, and orchids in houses throughout Bangkok.

The most vivid example is the very successful introduction of low-technology hydroponics into the homes, particularly the rooftops, of a dense squatter area of Bogota called Jerusalem. This was achieved in containers placed on very light wooden structures in up to three layers, and is a highly productive activity directed primarily at supplying metropolitan supermarkets. The women farmers typically earn as much as (or more than) their semi-skilled husbands.[18]

18. Zapp, Jorge (1991), "Cultivos sin tierro: hidroponia popular", UNFIE/PNUD, Bogota.

## IV. CONSERVATION OF RESOURCES THROUGH URBAN AGRICULTURE

SO **FAR,** WE have described idle resources of cities and towns that can be **utilized** for agricultural production, whether as inputs or as cultivable surfaces. Another way of looking at the relationship between urban agriculture and resources is that some other resources can be **conserved** through urban agriculture. The contribution of urban agriculture to the conservation and better use of energy, bioregional ecologies, and human resources will be outlined next.

We will begin with the most straightforward cases of resource conservation. Simply put, urban agriculture saves **energy.** On average, the food in a supermarket in the United States travels an estimated 2000 kilometres (1,300 miles) between its point of production and its point of consumption. With increased urban agriculture, this average distance can be cut significantly. In other countries, the distance saved may not be as great but the impact may be greater. The resulting savings in energy and transport costs are obvious. Not so obvious are the savings in storage, including cold storage, and the savings in product lost due to handling and transport.

Urban production of fuelwood (eg. eucalyptus) can substitute for other, imported sources of energy, or for fuelwood grown at greater distances. It may help to reduce the expansion into rainforests and other fragile ecosystems, while helping to clean the air in cities.

The concept of "fungibility" is crucial to explaining further contributions of urban agriculture: some resources can be substituted for others, freeing them for alternate uses. This has relevance to urban agriculture, both at the macro and at the micro levels. An analogy here would be useful. Recycling a newspaper does not save the tree in the Amazon from which that paper came, but rather helps save another tree that would be cut to make another newspaper. Similarly, urban agriculture can be seen as allowing rural agriculture to become more focused on those methods and crops where there is a clear advantage for generating income, including export crops.

At the household level, this concept of "fungibility" has even more important implications. In many large urban areas, lower-income households spend over half their incomes on food.[19] As the largest component of household expenditure, any saving on food expenditure translates into a significant portion of the income becoming available for other non-food expenditure. Similarly, if urban agriculture results in surpluses that are sold or is undertaken specifically for the market, the resulting addition to the income can be sizable. Either way, the relationship between household income and the contribution of urban agriculture is clearly vital as household resources are either expanded or freed for reallocation. Cases of women in urban households earning more from food production than their government/worker husbands were not unusual.

19. Population Crisis Committee (1990), *Cities: Life in the World's 100 Largest Metropolitan Areas,* Washington, DC.

The concept of "fungibility" can be extended to the conservation of bioregions and their resources. Urban agriculture can reduce the pressure to convert deserts, mountain slopes and rainforests into cropland, as well as the pressure to cut woodlands for fuelwood. Likewise, aquaculture has been one of the fastest growing farming systems of the 1980s. As cities grow their own fish and other aquatic crops, the pressure on the oceans and other water bodies outside metropolitan areas can be reduced. The much higher yields from urban agriculture techniques when compared to those from rural agriculture can make these reductions in pressure particularly significant.

A final type of resource that can be conserved through urban agriculture is the human resource. Many of the residents of urban areas in Third World countries still have strong links to the rural realm. With those links come a knowledge and appreciation for working the land and the water. It would be a mistake to leap to the assumption that rural farming skills can be transferred without modification to urban agriculture. By and large, rural farming systems do not work in the city. Rather, rural roots establish a basis or context for action. Some of the body of knowledge and outlook is transmitted to the next generations. Thus, the urban migrants and refugees can be recognized as human **resources.** This is particularly the case in instances of "underemployment", where not only is knowledge available, but also time.

Furthermore, urban agriculture offers opportunities to some groups in particular and thus has positive impacts on equity. In many cultures and places, urban agriculture is women's agriculture. Moreover, urban agriculture by its nature is a low-capital high-labour industry and attracts small low-income entrepreneurs and employs part-time and temporary low-skilled workers.[20] Thus, the urban agriculture industry provides income to new arrivals in the city, teenagers, retired persons and child-carers.

20. Freeman, Donald B. (1991),*A City of Farmers,* McGill/Queens University Press, Montreal. Part 3, pages 103 to 122, analyzes the significance of urban agriculture to the community and to the nation.

## V. CONCLUSIONS

IT **CAN** BE concluded that sustainable development is unthinkable without sustainable urbanization, as during the next generation we cross over the threshold where more than half the world's population will live in urban areas, and as urban per capita consumption (resource through-put) continues to increase its advance over rural per capita consumption.

Ecologically sustainable urbanization is also inconceivable without urban and peri-urban agriculture, as can be seen in the cases noted in this paper and in others which will be covered in a monograph now in the process of publication. Briefly, urban agriculture is the largest and most efficient tool available to transform urban wastes into food and jobs, with by-products of an improved living environment, better public health, energy savings, natural resources savings, land and water savings and urban management cost reductions. We have concluded that the place to begin urban agriculture as a programme towards ecologically sustainable cities is in the low-income neighbourhoods, for several reasons. First, these are the fastest growing portions of Third World cities. Second, these neighbourhoods have on average the worst environmental conditions - and the poor environmental conditions "spill-over" to the rest of the city and the bioregion.

Urban agriculture is the programme of choice because: it is low-capital and high-labour (and thus well suited to low-income families). While improving the environment, it produces food and health (green city = healthy city). It produces jobs and enterprises and improves economic security. It contributes to social sustainability while increasing ecological sustainability.

Urban agriculture is truly a vast "opportunity missed". The opportunity is missed because much more can be accomplished with existing technology and because little effort has been put into optimizing the capacity of urban agriculture.

We hope that this article will be a challenge to stimulate:
- surveys of what urban agriculture is in many diverse places;
- analyses of the farming systems that make up urban agriculture;
- studies of the costs and benefits of urban agriculture;
- studies on the implications of urban agriculture on urban planning, environment and poverty;
- demonstration projects, particularly South-South technology transfer; and
- conferences to share information and, of course, publication.