Urban Agriculture

Food, Jobs and Sustainable Cities

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Chapter 7
Benefits of Urban Agriculture

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Benefits of Urban Agriculture

Urban agriculture benefits the economy, environment, and well-being of those active in the industry, as well as residents who enjoy its products **(Fig. 7.1).** It plays a role in programs and projects that target health and nutrition, the environment, enterprise development, income generation, water and sanitation, youth and women, and food production and supply.

The current and potential roles of urban agriculture differ from country to country. In countries that must export agricultural products to earn foreign exchange, urban agriculture can feed the cities while rural farmers concentrate on exports. In countries with a fragile ecology, the intensive production technology of urban agriculture and its capacity to absorb urban waste may be essential to averting environmental disasters in urban areas.

Food Security, Nutrition and Health

Factors that influence the health and well-being of individuals include the quantity, quality, regularity, and nutritional balance of their food, as well as the quality of their living environment. Urban agriculture contributes to the health and well-being of a community by reducing hunger, strengthening access to food, improving nutrition, and improving environmental conditions that affect health (Table 7.1). The benefits offered by urban agriculture are thus both quantitative and qualitative — increasing food quantities reduces hunger, while improving food quality fosters better health and nutrition.

Determining the potential nutrition and health benefits of urban agriculture in different locations first requires identifying the extent of urban food insecurity, malnutrition, and hunger. Food security, a prime condition for personal and family well-being, is initially definable as the absence of food insecurity. Malnutrition and hunger are the result of food insecurity.

Urban agriculture can contribute significantly to combating urban hunger and malnutrition in several ways:

- Production for self-consumption and barter increases the food security of the poor by making it possible to obtain food they could not otherwise afford or find — even during bad financial times. Because daily food intake does not depend on their unstable daily income, poor families gain control over the quantity, quality, and stability of their diet.

Table 7.1 Impact of urban agriculture on health, nutrition, and well-being

Country	Impact
Africa	
Kenya	Twenty-five percent of the country's urban population depends on self-produced food for nutritional survival.
Uganda	In Kampala, children of low-income farming families were found to be as healthy as children of wealthy families and healthier than children of non-farming low-income families.
	Save the Children Fund recommended that supplementary feeding programs in low-income areas of Kampala were not needed, and that urban food production was a factor.
Zambia	A severe economic crisis led to increased food production in Lusaka. By 1977, 43 percent of a low-income community was farming home gardens and 57 percent in other city farms — saving 10-15% on food costs.
Asia	
China	In Shanghai, vegetables grown in the metropolitan area are very fresh, and reach markets 10-15 hours after harvest.
Indonesia	In Java, home gardens supply about 18 percent of caloric consumption and 14 percent of proteins.
Nepal	In Kathmandu, 41 percent of the average daily total food intake was derived from household production. Thirty-seven percent of households polled in a survey reported that they met plant food needs through household production. Households reported consuming an average of 72 percent of home plant production and an average of 86 percent of home animal production.
Philippines	On the island of Negros, malnutrition among urban and rural children was reduced from 40 to 25 percent two years after the start of biointensive gardens.
	In Cebu City, horticulture combined with public health interventions increased vitamin A levels significantly among children and provided other nutritional benefits that supplementation and fortification interventions alone did not.
Latin America	
Argentina	In Buenos Aires, 20 percent of nutrition needs of the city is produced by part-time farmers.

Source: Data compiled by The Urban Agriculture Network from various sources.

- Urban agriculture provides the poor with control over the nutritional balance of the family diet. More expensive food items such as fruit, vegetables, and meat can be supplied through home production. This improved nutritional balance reduces protein and energy malnutrition as well as deficiencies of essential micronutrients and vitamins.
- Urban agriculture provides fresher food. Food from outside the city — especially perishables like fruit, vegetables, and fish — loses part of its nutritional value during transit and storage.

- Local production may reduce prices because food passes through fewer middlemen, and transportation and storage costs are lower. Local production makes food available in the neighborhood and thus improves physical access.
- By reducing the percentage of the family budget that is spent on food, urban farming makes income available for other expenditures, including healthcare and education.
- In many countries, urban farmers are more likely to be female than male. Thus urban agriculture helps ensure children's access to food, enhances their health status, and contributes to empowering women.

Food Security

Urban agriculture has proven its contributions to urban and national food security countless times, most notably in recent years. As more frequent and more damaging disasters confront a population that is moving to the world's cities, urban farming often offered a critical solution.

Food Security and Poverty

Food insecurity can be measured at many levels — from the individual all the way to a region or country. The Economic Research Service of the USDA states that " . . . food insecurity is the most severe in sub-Saharan Africa followed by south Asia. South Asia has the highest number of food insecure. Certain countries in Central America and the Caribbean have very high levels of food insecurity".1 Slightly over 10 percent of the population in the USA is food insecure. Table 7.2 identifies 23 large cities in the developing world in which the total population spends over half of its income on food. Within those cities — and many, many others — a very large share of the population is food insecure by definition because the majority of the population in those cities earns less than one-half of the mean family income used in the table.

Rapid urban expansion that races ahead of the requisite infrastructure and service systems, including the food system, engenders food insecurity. This is particularly true for essential protein and micronutrient elements of the diet. Food insecurity has most commonly been measured at the household or family level, where the hurdle to food security is most commonly access to good food. Access, compared to availability, implies that the family has either money or direct access through self-production or barter. Availability within the city or market does not provide access. In developed economies, food insecurity tends to be co-located with poverty, while in underdeveloped economies the spatial patterns of food insecurity are more dispersed. Urban agriculture as an agent of food security can be effective throughout a city, core to periphery, and thus has special relevance in low-income countries.

Food security is becoming an increasingly critical issue as the rate of urban poverty rises, and evidence indicates that food security and nutrition are worse among the urban poor than the rural poor. A study undertaken by IFPRI in eight large countries (representing two-thirds of the global population) found poverty to be increasing in urban areas more than in rural, and the locus of poverty shifting to urban areas.[2] Although on average the nutritional status of children (stunting and underweight) is better in urban than in rural areas,[3] intra-urban differentials among the rich and poor are very high. In

cities, malnutrition, morbidity from diarrheal diseases and parasitic infections, and infant mortality are up to three times higher in lower income areas than in upper income areas.[4]

Table 7.2 Cities spending 50 percent or more of household income on food (among the world's 100 largest metropolitan areas). A comparable number of cities spend 40-49 percent of household income on food.

City	Household income spent on food (%)
Ho Chi Minh City	80
Lima	70
Katowice-Bytom-Gliwice	67
Dhaka	63
Kinshasa	63
Bangalore	62
Calcutta	60
Guangzhou	60
Istanbul	60
Lagos	58
Bombay	57
Pune	56
Algiers	55
Nanjing	55
Shanghai	55
Wuhan	55
Harbin	54
Recife	54
Beijing	52
Shenyang	52
Tianjin	52
Alexandria	51
Sao Paulo	50

Source: Reprinted from Sally Ethelston. 1992. Food Costs in Cities. *Hunger Notes* 18(2):16.

Lower-income groups are generally likely to gain the greatest advantages from urban agriculture. Farming improves the food security of the poor through increased availability and access to food, as well as through increased availability of cash to purchase food. Farming can also raise the nutritional status of the poor household by improving the nutritional balance of the diet and providing micronutrients.

Simultaneously, research in cities from sub-Saharan Africa to the Indian subcontinent has shown that two-thirds or more of their economies resides in the informal sector. Food is procured in both rural and urban areas by purchasing, self-production, or through transfers — public (food aid, food coupons) or community-based (barter with relatives). Beyond these general similarities, food procurement and consumption behavior by the poor in urban and rural areas differs significantly.

Food security for the poor is more difficult in urban areas because:

- self-production is lower and dependence on cash to purchase food is higher,
- urban areas have fewer community safety nets, and
- complex formal supply channels that are subject to failure and constrictions that raise food prices play a greater role.

Moreover, poor urbanites often pay more for food than richer urban residents because they purchase small quantities and must travel further to reach places where food costs less.[5] In most low-income cities, non-farmer food costs represent a substantial share of total household expenditures. In urban areas of low-income countries, 40-70 percent of the family budget is spent on food and fuel (Table 7.2). The poorest people in those cities often spend 60-90 percent of their budgets on food, often facing hunger when they cannot afford such price levels. Thus urban agriculture can make a substantial contribution to the economy of poor urban households.

Urban Agriculture and Food Security

Urban farming is an integral part of the urban food supply in most lower-income countries. It tends to provide products that rural farming cannot supply as well — perishables that suffer during transport, high-value crops that need close monitoring of the market, and certain export crops that require rapid delivery when ready. It is thus complementary rather than competitive with rural farming, contributes to the national economy, and increases the efficiency of the food supply.

Urban food security is often contingent on urban agriculture, particularly for millions of urban poor who depend heavily on cash for procuring food. With undependable day labor or insufficient income, self-production is a critical strategy for food security.

A majority of urban farmers (70 percent in Kenya) are low-income agriculturalists, producing first for household consumption.[6] Improving household food security and well-being is the main motive for the poor to farm in cities — as is shown by the repeated evidence from countries in Asia, Africa, and Latin America throughout this book. In Dar es Salaam, urban farming contributes 20-30 percent of all household food supplies. Including contributions to income, urban farming satisfies about 40 percent of household

food needs, particularly through vegetables.[7] One-fifth of the food consumed by squatters in Jakarta is produced within the community.[8]

Food producers in Nairobi slums interviewed in 1995 stated that they placed a high value on home-grown food because "the food we harvest has a greater value compared to any wages we would get if I or another family member got a job", given the high cost of purchasing food. While most farmers reported that they do not grow crops expressly for sale, at times crops are sold to finance emergency expenses. Some crops may be sold in part if perishability is high and storage is not possible, and others that are easy to sell are selected for growing.[9]

Urban farming can make a difference in both farming and non-farming households. In the Korogocho area of Nairobi, at least one-half of the food consumed was derived from self-production. Non-farmers, however, have a higher dependence on donations, gifts, and barter (from farming households among others) as a food source.[10]

The contribution of urban agriculture to urban food security is particularly significant when rural supplies are inadequate or in situations where economic or political factors (war, civil strife) cause disruption to food supplies. Urban agriculture was a significant source of food in European cities during World War II, as well as in Sarajevo in the 1990s. Most longer-established refugee camps and communities — such as the camps along the borders of Rwanda and Burundi in Tanzania, and the Mozambican refugee communities in Malawi in the 1980s — have developed urban-style farming to supply food for the communities and for local sale. Contributions made by urban agriculture during such special times are detailed later in this chapter.

The increasing problem of food insecurity for the urban poor in many developing countries has led government and development agencies to address the problems of hunger and malnutrition by instituting a range of safety-net and coping strategies. These include food aid, food coupons and subsidies, price control over basic foods, programs aimed at school children and feeding mothers, and targeted distribution of iron, vitamin A supplements, and iodine tablets. Most require high and continuous costs to the state.

Among these strategies to combat hunger, farming in poor urban neighborhoods is rarely promoted (notwithstanding exceptions such as Argentina, Cuba, and Romania), yet it is the main coping strategy of the poor and is a self-help strategy. More cost-effective and more empowering than providing food aid, urban agriculture is thus more sustainable. Urban farming is increasingly encouraged by particular agencies as a food security intervention, but has yet to constitute a central component of broader government strategies.

NGOs often act as the catalyst to push for food security measures (including urban farming), with governments later seeing food security as more than just hunger relief. In Haiti, a CARE International project helps the poorest urban residents grow food for consumption and sale. Also in Haiti, Educational Concerns for Hunger Organization of Florida is helping poor residents grow vegetables intensively in shallow beds on rooftops (see Case 5.2, Russia).

The full benefits of urban agriculture become clearer by going beyond the idea of food security to consider the recent concept of community food security (CFS) (defined

in Chapter 1). This hybrid concept borrows elements from several fields, including "anti-hunger's concern for the food needs of low-income persons; ecology's systems-thinking; sustainable agriculture's concern for how food is produced; public health's prevention-based strategies; and community development's community-building and place-based focus".[11]

Urban Agriculture and Community Food Security

Urban agriculture is one of the essential components of community food security, and should be incorporated into any strategy that seeks to achieve its objectives. When reviewing the elements cited above, urban agriculture:

- has a special capacity to strengthen access to food by low-income and other vulnerable groups;
- exemplifies the multiple links among an urban food supply system and other systems (transportation, land use, waste management, etc.);
- incorporates innovative food delivery processes, such as community-supported agriculture and organic hydroponics;
- enables preventive health measures, notably nutritional improvements and safe waste management, among groups that may not otherwise access good food; and
- localizes food production, bringing it close to the consumer and making it place-specific (because certain crops are especially suited to certain places).

The last point is advantageous on several levels. Besides the obvious transportation savings, other benefits include fresher products, higher correspondence between supply and demand, and greater awareness of the role of agriculture.

The principal relevance of CFS is the focus on the poor and others who are vulnerable to food insecurity. In the past decade several innovative urban farming approaches have contributed to local food security. In the USA,[12] for instance, examples abound. [13]

- The importance of healthy school meals has gained new attention, with Santa Monica's Market Salad Bar and its links to vegetable farmers in Southern California perhaps serving as the exemplary case.
- In Atlanta, a program provides skills and income to inner city teenagers by training them to produce, process, package, and market specialty products such as pickled peppers and loofah sponges.
- Within the Cook County Jail complex, inmates harvest vegetables for Chicago's poor and homeless through a food distribution site operated by the federally-funded Women, Infants and Children program, and through a restaurant for the homeless.
- The recent growth of gleaning programs to distribute food to those in need depends in particular on farms that are in and around American metropolitan areas.[14]
- From inner-city Los Angeles to small towns in Iowa, the Community-Supported Agriculture (CSA) model is being adapted to deliver produce weekly to low-income households.
- In Austin, Texas, a farmers' market was set up alongside a community garden within the poorest neighborhood in the city.

- Direct marketing relationships have been set up between small-scale farmers from Southern California and food service managers at food banks and residential rehabilitation centers in Oakland, California.

Among many urban residents, a survival mentality often overwhelms such desires as a clean, unpolluted environment and a safe, nutritious food supply. Programs such as those of the Hartford Food System (Case 7.1), however, have helped many people regain control over an environment that has been made hostile, thereby making food a vehicle for empowerment.

Case 7.1 The Hartford Food System and food security in Connecticut, USA

The Hartford Food System (HFS) is a private non-profit organization that has been working since 1978 to establish a localized food system by developing community food projects in the city and the surrounding state of Connecticut. The projects are meant to fill gaps left by the market economy and its 'conventional' food system.

Hartford proper (population about 135,000) has an overall poverty rate of 24 percent and a childhood poverty rate of 44 percent, making it one of the poorest cities in the nation. There are only two supermarket chain stores that serve the entire city, severely curtailing access to affordable food. A large poor and minority population suffers from chronic diet-related diseases and an infant mortality rate that exceeds the national average. Compounding the problems in Hartford, since 1982 Connecticut has lost 17 percent of its farmland to development. The state's food is also more expensive and lower in quality than the average for the USA.

The Hartford Food System has been using farmers' markets, a Community-Supported Agriculture (CSA) project, community gardens, youth gardens, solar greenhouses, and a direct farmer-to-school marketing program to put the urban consumer back into the food picture. The overall program is called Farm to Family and its purpose is two-fold:

- to restore the links between Connecticut's farmers and low-income communities by launching programs that target both consumers and institutional food providers such as the school lunch program; and
- to give low-income residents an opportunity to participate in their food system through food production and distribution projects.

In 1987, HFS established Connecticut's Farmers' Market Nutrition Program to provide low-income mothers, their children, and seniors with the opportunity to purchase locally-grown fresh fruits and vegetables in their neighborhoods, while also creating an incentive for local farmers to market their produce in the inner city. The program began with 21 farmers at three markets that provided more than 4,000 Hartford women and children with 80,000 pounds of produce for US$ 21,000. By 1994 the program had expanded across Connecticut to include 40 markets and 155 farmers who received well over US$ 300,000 in coupon sales from 43,543 low-income clients and 5,800 senior citizens.

In 1994, HFS embarked on its newest venture in hands-on food production, the Holcomb Farm CSA project. Located on a 318-acre farm owned by the nearby town of Granby, CSA is the Hartford area's first community-directed farming project. CSA unites the region's residents in a common effort to build a local source of high-quality safe food. In its first year, CSA produced more than 32,000 pounds of vegetables on 5 acres, which was distributed through five Hartford community organizations. The program doubled in size the next year.

The majority of Hartford's schoolchildren are at risk of hunger; for many, the school lunch program provides their only complete meal for the day. Recently, HFS launched Farm Fresh

Start, a demonstration program designed to increase the amount and variety of locally-grown produce served in public school meals, while also creating market opportunities for organic and low-input growers.

Contact: Mark G. Winne (see Appendix F for complete address).

In Great Britain, as in many wealthier countries, community-based food system movements include a shift from individual or family gardening as a constructive leisure pursuit to organizing a community to be accountable for its food security. As part of this change, there is a movement to convert allotment gardens to community gardens. As some observers remarked, "Allotments could not aid the local economy like community gardens may, with the selling of produce and perhaps running the garden as a business venture."[15]

Nutrition and Health

Nutritional status is a function of environmental and physical health, food security, caregiving, and nutritional quality of food. Urban agriculture has the potential to enhance the nutritional status of urban residents in general, and the urban poor in particular, by directly improving food security and nutritional adequacy.

For the poorest with unstable incomes, daily dietary intake varies depending on that day's income and prices in the market. They may thus suffer from hunger for part of the year. Many studies show that low-income urban dwellers spend a very high share of their income on food and yet face nutritional deficiencies due to poor diet, poor sanitary environment, and high rates of infection.[16]

The World Bank and others have developed 'healthy days of life' and other quality-of-life indicators to measure a society's health and well-being. Studies indicate that 40-75 percent of adults and children living in low-income urban areas in poorer cities have diseases that limit their capacity to learn and work.[17] By reducing hunger and malnutrition, urban farming makes the urban poor healthier, more productive, and more resistant to diseases. While the health benefits are generally greatest among the poor, other income groups also gain nutritionally from urban agriculture — middle-income kitchen gardens, a common sight throughout the world, contribute to improving the nutritional status of middle- and higher-income families.

Nutritionists have determined that the dietary intake of preschool children is an important factor for healthy mental and physical development. Hunger and nutritional deficiencies can lower productivity and shorten life. Child hunger can occur as a result of poverty, an inadequate food supply, or a distribution system that both increases the cost and availability of food.[18] In some social groups, women and female infants may be given less food than male members of the family, making them particularly prone to hunger and malnutrition.

The few studies available on nutritional differences among urban farmers and non-farmers show significant nutritional benefits associated with urban agriculture. A striking example is provided by a study in Kampala, which found that children of low-income

farming families were as healthy as children of high-income families and healthier than children of non-farming poor families.[19] A 1994 study in Nairobi found average kilocalorie intake to be highest, and stunting and wasting among children to be lowest, in households that participated in an urban agriculture program run by the Undugu Society, followed by households that independently practiced urban farming, and finally in non-farming households.[20]

Household gardens as nutritional solutions have been promoted by several international agencies — including FAO, UNICEF, Save the Children, Mennonite Christian Committee, American Friends Service Committee, and Oxfam — especially to increase the vitamin and micronutrient intake of mothers and growing children. The U.S. Agency for International Development's Vitamin A Field Support Project (VITAL) reports several studies that found a significant increase in vitamin A consumption is related to home gardens.[21] Most of these programs, however, target only the rural poor, which in many countries ignores the majority of food-insecure poor — the urban poor. Important exceptions exist, such as the gardens associated with community kitchens in Lima, Peru (Case 7.2).

Case 7.2 Growing food for community kitchens in Lima

Community kitchens (*comedores populares*) in Lima, Peru are run mainly by women who serve cooked food to their members, who are predominantly from poor communities. Traditionally, rice, beans, and oil are subsidized by the government and international aid. Kitchen members raise small livestock at home for use in the kitchen.

In the first half of the 1990s, CARE International collaborated with HUFACAM (the division of the Ministry of Agriculture that promotes urban farming) and the Ministry of Health to promote community gardens for the *comedores*, which grow vegetables and fruits to improve the nutritional quality of the food. These gardens, typically 100 square meters, are on government land, for example, in small parks, at health centers, or playgrounds. CARE provided seeds and a technical expert, while the government provided a social worker to help organize the farming activity. In some cases, CARE and the government helped with access to water.

The farmers used household and street waste, as well as the manure from their home livestock, to enrich the soil. Facilitating health workers reported that the gardens have immense nutritional benefits and help create self-reliance and empowerment within the communities.

Starting in the mid-1990s, governmental support for the community kitchens (through HUFACAM) was withdrawn as part of a more general shift in priorities (see Case 2.9).

Contact: Manuel Orozco Ramos and Lucila Alegre de la Cruz (see Appendix F for complete addresses).

With adequate crop selection and awareness of nutritional qualities, household gardens can be expected to have a beneficial impact on nutritional balance and micronutrient intake of the farming household. The Helen Keller Institute implemented pilot home garden projects in Bangladesh, and an evaluation of program participants found improved nutritional status of women and children.[22]

Two examples of urban projects that promote gardening for nutritional benefits are the Sup-Sup Garden Project in the Solomon Islands and the Thailand Vitamin A Improvement Project. In the Solomon Islands, the Honiara city council worked with the Sup-Sup Garden Club to increase the number of home gardens by 20 percent in two years.[23] The Thai project used a strategy similar to the Sup-Sup Gardens, except that a single food, ivy gourd, was promoted. An initial review showed expanded production and increased consumption by children.[24] It is important, however, for gardening initiatives to be well planned so that they fit local circumstances. For a number of reasons, many household gardening projects have failed.

Where farming by the poor has been systematically supported by development agencies, long-term and sustainable benefits are reported, as shown in two Philippines cases. In Negros, malnutrition was reduced in two years from 40 percent to 25 percent among participant families in a program that promoted biointensive home gardens.[25] In Cebu City, horticulture as a public health intervention provided more significant increases in vitamin A levels among children (as well as other nutritional benefits) than other, more standard supplementation and fortification interventions (such as targeted supply of iron, vitamin A, iodine tablets).[26]

The benefits of fresher food from local production are available not just to farm families, but to the entire city. Too often, market fruits, vegetables, and meats go bad due to long journeys and lack of proper storage. Urban agriculture helps make fresher produce and meat available. In Shanghai, production and supply of vegetables is managed so that they reach the market within 10-15 hours of harvest, which maximizes freshness and nutritional content (see Case 6.4). Urban agriculture is particularly adept at stretching the season (and consequently the period of nutritional gains) through the use of compost, waste heat, plastic, and other forms of sheltered production.

Nutritionists have been surprised that even civil war or economic crisis often produce relatively little additional urban malnutrition or hunger in some cities. After Zaire's economic collapse in 1991, malnutrition in Kinshasa was less prevalent than might have been expected.[27] In Baghdad and Sarajevo in the 1990s, residents planted gardens to provide for their nutritional needs.

Nutritional gains are clearly the greatest health benefit from urban farming, but they are far from the only benefit. Farming also cleans and greens the living environment, reducing pollution and disease-causing pathogens and vectors. Household waste and refuse can also be recycled for agricultural uses, providing additional environmental and human benefits by reducing waste scattered around the urban environment.

Finally, the presence of green spaces (including agricultural ones) undoubtedly increases the sense of well-being of urban residents, particularly at a child's level. Greenery is likely to benefit mental health, as empirical studies have demonstrated. For instance, patients at a hospital in suburban Pennsylvania were found to suffer less depression if their windows looked out on trees rather than a brick wall. Beyond the passive act of looking at plants, the therapeutic benefits of actively participating in planting and other agricultural efforts have also been recognized. Therapeutic horticulture has become a specialty in its own right within the health professions, and has its own association.

Improved food security and nutrition are the main direct benefits to poor households that farm in cities, and are a very critical coping strategy. Yet most governments, rather than promoting and encouraging this coping strategy, tend to oppose it, even if only on paper. In many instances, the food security and health gains are largely obtained haphazardly through the sheer efforts of farmers themselves. Food security and health improvements within the community can be planned by a range of public and other institutional interventions (see Chapter 11). The first step should be a proper understanding of the food system of a community, a city, a region, a country.

Social Benefits

The benefits of urban agriculture to farmers and their families are a springboard for its benefits to society. Urban farming improves social equity by improving the health and productivity of poorer populations and providing an opportunity to earn additional income. The health, income, environmental, and other benefits of urban agriculture to low-income farmers all make strong positive social contributions.

The poor are not a single homogeneous group. Some are more vulnerable than others. As a survey by the International Labor Organization found in Tanzania, urban agriculture often helps the weakest members of poorer communities disproportionately, a group that includes the aged, youth, women, migrants, immigrants, refugees, and people in long-term civil crises. The work opportunities provided by urban agriculture generate employment and income for those who have the fewest employment opportunities.

Urban agriculture is a way for people in these groups, and day-wage earners and the unemployed, to become entrepreneurial. Women growing hydroponic vegetables in the slums of Bogotá, for example, typically produce incomes that exceed their husbands' salaries (see Case 5.3). Through urban agriculture projects such as a Peace Corps project in the Dominican Republic, youth have not only learned to achieve stable income, but to become accountable for the environmental well-being and food security of their communities.

Urban cultivation is frequently undertaken through community organizations. When successful, such community efforts in urban agriculture are an effective means of empowerment, as the International Food Policy Research Institute found through a home gardening project it studied in Guatemala.

Urban agriculture also contributes to a community's well-being by improving its aesthetics and solidarity (Case 7.3). Neighborhoods that include urban agriculture generally have higher levels of social interaction and better security, in part because the activity is on the streets rather than behind closed doors. Neighbors tend to share a concern for the success of the enterprise and often the fruits of its labor as well.

Food insecurity for the individual of any age is an increasing problem because urban families in the 21st century tend to be less cohesive. Diseases, including AIDS and malaria, break down the family structure. The number of urban homeless is growing in many countries, both rich and poor. Urban agriculture has the potential to empower each of these social groups to recover food security as a first step to well-being.

Case 7.3 Relocated households gardening in a new neighborhood in the desert near Cairo

Gardening can be a crucial tool for dislocated households to adjust to new environments, an important step in the formation of new communities. This was exemplified in Cairo following the October 1992 earthquake. Starting only one year after the earthquake, 10,000 families obtained apartments in a new housing complex on the desert plateau east of the city. As early as 1995, while the area (nicknamed Earthquake Quarter by its inhabitants) was still a construction site, small gardens could be detected outside many ground-floor apartments.

While some gardens were planted with only decorative and shade plants, many other residents planted herbs and vegetables and raised small livestock. Interviews confirmed their adaptive role within this new and harsh environment. Most of the new residents used to live in dense neighborhoods of inner Cairo, so they had not been accustomed to gardening except on balconies and roof tops. They saw gardening as a new opportunity, one that mitigates the hostile environment provided by the new housing.

Interviews revealed that the residents always regarded their gardens as multifunctional — food production combined with other purposes such as greening, rest, and privacy. As one resident put it, "I set up a garden with my husband in front of the housing block, to have a nice view, to raise some chickens, to plant some lettuce and radish." The gardens, while small, mitigated some of the high food prices at the neighborhood market, prices that were partially explained by the neighborhood's isolation at the edge of Cairo.

The privacy offered by densely planted ground-level gardens cannot be underestimated, nor can their social and recreational functions. The latter is particularly important since no collective public facilities (other than a public park) were provided on site. The less tangible purpose of adjusting to a strange new setting is also vital. Claiming the space outside the apartment (often spilling onto the public domain, with a narrow passageway left for pedestrians to pass) occurred as rapidly as the transformations that were applied to apartment interiors. Gardens were a vital element of acculturation to a new setting.

Contact: Bénédicte Florin (see Appendix F for complete address).

A less tangible benefit than those already identified is individual empowerment. This became clear in the Peruvian capital of Lima. Peru Mujer, a non-governmental organization (NGO) administered a comprehensive and well-planned community gardening program until 1994 that contributed to improving the food security, nutrition, and health of 5,000 families in Lima.[28] Most of the community gardens, each consisting of about 40 plots of 60-200 square meters, were farmed by low- and middle-income women growing biointensive vegetables, mainly for consumption. Besides providing training, extension, marketing, and processing support, Peru Mujer created organization and leadership structures among the farmers. This experience showed the improvements that urban agriculture can bring to women's lives beyond nutrition and income — better self-image, higher standing within the family, and elevated social and economic position within the community. This benefit is especially important because in most countries a high percentage of urban farmers are women.

Economic Benefits

The economic importance of urban agriculture has received little attention to date. Scholars have tended to regard it as a subset of rural agriculture or the informal sector, or as merely a temporary phenomenon. The available data suggest, however, that the economic benefits of urban agriculture are at least as great as the nutritional and environmental benefits.[29]

Food is the largest single element of the urban economy in the majority of towns and cities in the developing world, and one of the top three elements in high-income countries. Adding to the economic base of a city with agricultural production and processing provides it with a solid foundation.

Urban farming is a competitive economic activity and the industry of choice for millions of urban entrepreneurs. It provides income-generating opportunities for people with low skills and little capital, as well as for people with limited mobility, including women with children and the elderly. For many private and public entities — including port authorities, hotels, restaurants, airports, municipalities, and electric and water utilities — it provides opportunities for a secondary income.

Urban agriculture often exploits unused resources in the city — wastewater, solid waste, vacant lots, bodies of water, and rooftops. It puts idle land to productive use, either by paying competitive rent or through usufruct use, and maintains the land in good condition for the owner. For countries with foreign exchange problems, urban agriculture can be an import-substituting industry.

The economic benefits of urban agriculture can be discussed in terms of its role in:

- employment, income generation, and enterprise development;
- the national agriculture sector; and
- land-use economics.

Employment, Income Generation, and Enterprise Development

It is not surprising that both low- and high-income entrepreneurs choose urban farming as their industry. Risk is low because food is a basic consumption item with a stable and dependable demand, even during an economic downturn. Because they are close to markets, urban farmers can tailor their production to demand and supply high-value and perishable items. Proximity to the market also gives farmers a competitive advantage by saving transportation and storage costs.

Whether small or large, legal or illegal, informal or formally recognized, urban farmers around the world are producing competitive incomes through farming(Table 7.3). In Jakarta, a group of farmers runs a profitable vegetable farm on allotted land in return for services inside the grounds of a racetrack. Poultry farms holding a few thousand birds are a common sight on the outskirts of many cities.

Urban food production has a significant multiplier effect on the urban economy. It generates economic activity in related industries, including those that supply agricultural inputs, as well as storage, transportation, canning, marketing, and food processing (Case 7.4). Street food vendors in Bangkok and elsewhere grow their own food and cook it for

sale every morning.[30] In Bamako, Mali, entrepreneurs supply compost excavated from garbage dumps to meet farmers' demand for fertilizer.

Urban farming provides secure jobs to many in the city. In some cities, as many as one-fifth to one-third of all families are engaged in agriculture, with up to one-third of these having no other source of income.[31] Tanzania's 1988 census found that urban agriculture was the second largest employer in the district of Dar es Salaam, population about 2 million (the first was petty trading and labor). One in five adults of working age in Dar es Salaam is a farmer.[32] In greater Bangkok, the Choroe Polphord conglomerate has contracts with no less than 10,000 poultry outgrowers. A great many of the outgrowers are small-scale entrepreneurs who provide employment to others. In Manila, the Urban Food Foundation farmers' cooperative includes 500 small-livestock producers. Thousands of such examples exist globally.

Table 7.3 Impact of urban agriculture on job- and income-generation

Country	Impact
Africa	
Tanzania	In Dar es Salaam, urban agriculture was the second largest employer in 1988 (petty trading and labor were first). Twenty percent of working-age adults participate in urban agriculture.
Zambia	In a program to expand and improve food gardens in Matete, the average annual income of participants nearly doubled in two years.
Asia	
India	Intensive farming on 800 hectares of garbage dumps in Calcutta employs about 20,000. Fisheries in sewage-fed lagoons employ 4,000 fishermen families and produce 6,000 tons of fish every year.
Thailand	In Bangkok, a poultry conglomerate contracts to approximately 10,000 outgrowers.
Latin America	
Argentina	In Buenos Aires, backyard gardens can provide 10-30 percent of the cost of a nutritious diet.
Colombia	Urban hydroponics supported by UNDP generates approximately US$ 30 per month on 10 square meters and requires only 1 hour of daily care. Up to 2 monthly minimum salaries (US$ 90-180) can be made on 30-60 square meters of planting.
North America	
USA	Kona Kai Farms in Berkeley, California generated $238,000 from one-half acre in 1988 through sale of organic specialty greens. Three employees are starting their own garden-farms.

Source: Data compiled by The Urban Agriculture Network from various sources.

The urban farmer has a competitive advantage in specialty crops and specialty markets such as exports. Food processing and marketing corporations benefit from urban farmers because their proximity ensures better contact and control over supply and quality as well as lower transportation costs, especially for perishable items such as mushrooms.

Large enterprises employing farmers or maintaining outgrower contracts bring the benefits of organization and scale to farmers. Agribusiness organizes marketing, financing, and technical assistance that allow the farmer to concentrate on production. The farmer is also assured that all his produce will be purchased so long as it meets quality requirements. The large enterprises use their size to gain access to markets, market information, and credit — difficult for small, individual farmers to obtain. Del Monte Corporation purchases fruits and vegetables from more than 100 small outgrowers in Manila (see Case 3.4).

Urban agriculture is an easy industry to enter. It can be started on a small scale, on informally accessed land (sometimes paying no or little rent), with few and inexpensive inputs, and limited technical knowledge and skills. The output at this stage is usually low and inefficient, but an enterprising farmer can, over time, improve the inputs, increase skills and knowledge, enhance production efficiency, and widen the scale of the activity — all with small incremental investments. Poor farmers, however, have little or no financial capacity to absorb economic shocks, especially when they have little official support.

Case 7.4 Integrated urban farming in Pikine, Dakar

In the community of Pikine in Dakar, Senegal, a cooperative of small entrepreneurs has succeeded in farming an unbuildable wetland area of tribal land. The farmers, who are mostly men, grow vegetables under trees and raise livestock, primarily for the market. Women do the marketing. Both men and women process and market related products such as dried fish, tanned leather, and handicrafts made from palm fronds. In addition, the marshier parts of the land are leased to rural itinerant rice farmers, and the rent is used for common projects.

The farmers follow sustainable agriculture practices, using waste from households, markets, and animals to fertilize the soil. In some cases, wastewater is diverted from sewage pipes to irrigate the crops, but in most cases water for irrigation is lifted by hand from shallow wells.

Animals are raised in home compounds and grazed in turn by tribe members on roadsides and vacant land. The women marketers buy fish from fishermen, process the fish, and barter the waste to the farmers for fertilizer.

The farmers' cooperative operates under the leadership of an elected president, who is also their tribal chief **(photo 5.4).** The farmers receive political support from the city mayor and technical assistance from the Centre pour le Développement de l'Horticulture, a government research institution working on horticultural techniques such as raised-bed monocropping. The institution is partly funded by the Food and Agriculture Organization.

The success of the farming activity stems from a strong organizational structure and the integration of marketing, processing, and land management.

Contact: Michael Bassey (see Appendix F for complete address).

Urban agriculture provides opportunities for unskilled youth, homebound mothers, and the elderly to participate in commercial activities. In Lusaka, for example, urban agriculture provides jobs for those whose skills do not qualify them for formal sector jobs — including women, teenagers, and retirees — at a higher rate than other informal sector activities.[33] Much urban agriculture work can be done at any time of the day, and there may even be certain advantages to working outside business hours (butchering, harvesting for same-day or next-day sale). Many tasks can be done on weekends.

On plots as small as 10 square meters, gardeners in Maipú, Chile and Takoma Park, Maryland, USA produce herbs and spices that they process and package at home for sale. The most dramatic example of enterprise development is probably that of a multi-millionaire urban agriculturist in Jakarta who began by selling eggs door-to-door that were produced by chickens raised on his parents' back porch (Case 7.5).

Case 7.5 Development of an integrated urban agricultural enterprise in Jakarta

In the early 1970s, Bob Sadino, a young high school graduate in Jakarta, Indonesia recognized the market for specialty food products and began a business that has turned into a multi-million-dollar urban agriculture success story. He began by importing chicks from the Netherlands, raising them in his parents' backyard, and selling the eggs to neighbors door-to-door.

Sadino expanded his business activity rapidly, selling chicks to other poultry farmers and dressed chicken to luxury hotels while continuing the door-to-door sale of eggs. In about four years, he had established a retail outlet in his family home and then purchased a meat processing plant, where he processed chicken as well as other meats.

Within a few years, Kem Chicks concentrated on processing, wholesaling, and retailing. The enterprise produces specialty products for which there is less competition. High quality and reliability allow the company to command higher-than-market prices. A national or international expert is generally called in to set up production and train staff in new products. Kem Chicks also provides support to its medium- and small-scale outgrowers.

Kem Chicks now also includes a hydroponic vegetable farm, established with the help of a Japanese expert, and vegetable farms in the peri-urban area. High-value, rare vegetables are distributed overnight after harvesting to maintain freshness.

Kem Chicks exports several food products to Singapore, including dried fruit. The company has grown to employ about 800 people in addition to the outgrowers.

Contact: Bob Sadino (see Appendix F for complete address).

The economic base of cities is particularly strengthened because urban agriculture is counter-cyclical. Food is a basic consumption item with a fairly inelastic demand. Thus even when the economy is depressed, urban farming can still sell its products. Yet despite all its advantages, urban agriculture is frequently excluded from economic data collection and unreported in labor statistics. Individuals may not count their self-employment in farming as a job, and statistical surveys may ignore the money a family saves by growing food at home.

The National Agriculture Sector and Urban Food Supply

Urban agriculture not only contributes to improved economic conditions for individuals and families, but also offers a variety of macroeconomic benefits. In most countries, food is among the largest industries, and in many places, a significant portion of food production occurs within urban regions, where urban farming is a well-established and extensive industry (see Table 2.2). In many countries urban farming satisfies a significant percentage of the urban food demand and comprises a fair share of the nation's agricultural industry, in addition to being the main source for non-cereal nutrition for a large proportion of the urban poor,.

The U.S. Department of Agriculture found that one-third of the nation's agricultural product (in dollar value) is produced within urban metropolitan areas on one-ninth of the agricultural land.[34] Within their metropolitan regions, 18 large cities in China produce 90 percent or more of their vegetable demand, as well as a significant portion of their fish and small-livestock protein demand.[35] In the Dar es Salaam area, GTZ found that 90 percent of the spinach that was consumed was grown in the urban area. Urban agriculture is a major industry in these countries, in part through a policy decision to pursue urban food self-sufficiency.

In countries where food and fuel represent an even larger share of the total economy, urban agriculture may have an even more important economic share. Russia's small farmers produce 30 percent of its agricultural produce on 3 percent of the land, and three in five families in greater Moscow farm on a small scale, up from one-fifth in 1970.[36] Kampala, Uganda produces most of the poultry consumed by its residents. Bamako, Mali produces nearly all of its vegetables, as does Ouagadougou (Burkina Faso), and until recently, Shanghai (China).

Urban farming is particularly important in countries where the national agricultural marketing infrastructure has failed to catch up with growth in urbanization, particularly in most rapidly growing African cities. The importance of urban farming also increases when the rural food supply or the national agricultural marketing infrastructure is disrupted due to civil strife, such as in Baghdad, Kinshasa, and Sarajevo.

In addition to contributing to the city's food supply, urban agriculture helps low-income farmers produce food they cannot afford to buy. This does not displace rural supply because the poor have limited financial resources to purchase food in the market.

Most developing-country food imports are undertaken to feed the cities. Egypt and Tanzania are two well-documented examples of countries that import food with a priority for their urban population. Urban agriculture can substitute for some of the imported food.

The economic consequences of the structural adjustment programs of the 1980s are well known. The World Bank found that per capita income in dozens of countries was lower in 2000 than it was in 1990. In some countries, economic conditions have been worsening since the mid-1970s. One common response was to earn foreign exchange by exporting rural crops — the same crops consumed in urban areas. Policies were also instituted to encourage urban residents to grow their own food to save money and ease the economic situation (these efforts in Zambia are described in Case 9.1).

An early such case was Operation Feed Yourself in Ghana. It had considerable success during its 4-year life (1972-76) in reducing imports and feeding cities. Plantain crops increased from 202,000 to 840,000 acres, while okra acreage increased from 18,000 to 42,000. Urban farmers' associations operating today date to this period and still focus on urban farming for self-consumption.[37]

In the 1980s, Sri Lanka found itself in a balance-of-payments crunch because of the need to import rice, wheat, and other foods. Import restrictions imposed to save foreign exchange caused price increases and food shortages. This decision immediately generated a counterbalancing need for urban agriculture to feed half the country's population. To ease these problems, the government encouraged consumption of indigenous staple crops, including manioc, yams, and dry grains, which urban residents farmed in school gardens and their backyards.[38]

Many developing countries faced the new millenium deeply in debt and with a poor foreign trade balance. For some, it is possible and appropriate to put their good rural agricultural land into export crops and let the cities provide their food and fuel needs as much as possible through urban agriculture. Self-reliant cities thus advance rural agriculture's export goals. Nicaragua's government, for example, made a decision in the early 1990s to earn foreign exchange through agricultural exports. All the examples cited so far pale in comparison to the revolution in food supply that has transpired in Cuba during the past decade (Case 7.6).

Case 7.6 Cuban urban agriculture — from 'modern' to sustainable farming

In 1990, Cuba embarked upon the first national transformation from conventional modern agriculture to large-scale organic and semi-organic farming. The agricultural sector and the country's food security had been highly dependent on imports, a strategy that faltered when the Soviet Union crumbled. Suddenly, a country with a highly modernized agricultural sector found itself almost without chemical inputs, and with sharply reduced access to fuel and irrigation. Average daily caloric and protein intake by the Cuban population may have fallen by as much as 30 percent from the levels of the 1980s. Prior to this 'special period', and despite significant progress in domestic food production during the 1970s and 1980s, 57 percent of the total calories in the Cuban diet came from imports — a consequence of focusing on sugar production for export.

Cuba was now faced with a dual challenge — the need to double food production with less than half the inputs, and at the same time maintain export crop production so as not to further erode the country's meager foreign exchange. To Cuba's credit, with only 2 percent of Latin America's population, it has nearly 11 percent of its scientists, an advantageous position for the necessary transition.

Fortunately for Cuba, it had begun a National Food Program in 1989 that emphasized a dramatic increase in the production of *viandas* (traditional starchy crops) and vegetables, and to make the area in and around Havana as self-sufficient as possible. The leadership of Cuba had already embraced an 'alternative model' promoting crop diversity, organic fertilizers, and biological control. Eventually, a highly organized composting program using crop residues and urban garbage was developed, as was a composting program using worms. Crop rotations, intercropping, green manuring, and succession planting were officially adopted. Additionally, more than 200 factories were created to produce beneficial insects and pest pathogens.

Since 1991, more than 27,000 organic gardens covering 500 acres have been created in the Havana metropolitan area, producing an estimated 1 million tons of food annually. Within the 15 Havana municipalities and the abutting peri-urban districts, Havana is over 80 percent self-sufficient in vegetables. This achievement is particularly remarkable because the vegetable consumption by Havana's children increased four-fold during the 1990s.

Urban gardens take on three basic levels of organization in Cuba — individual and family gardens on private land, organized groups of neighbors on public land, and institutionally organized gardens. Garden sites are usually open or abandoned plots in the same neighborhood or even next door to the gardener's home.

A 1993 government decision to break up the enormous farms that accounted for 80 percent of Cuban agriculture turned those farms into profit-seeking cooperatives. As a result, Cuba had significant levels of production for 10 of 13 principal domestic food items for the 1997 growing season. Since 1989, Cuba has fully accepted the policy to promote a new approach to agriculture, including recognition of the importance of urban agriculture, and has moved substantially to implement this policy in research stations, extension services, and with farm producers.

Contact: Catherine Rosset and Maria Caridad Cruz Hernandez (see Appendix F for complete addresses).

In a world that is facing food shortages in many countries, an expansion in urban agriculture can reduce the pressure on rural land, especially the push onto new low-quality agricultural land. Intensified production methods mean that more people can be fed on existing cultivated land without putting additional stress on marginal lands.

Economic Use of Land

Urban agriculture is thriving in a variety of settings, from rich Tokyo to poor Kampala, and from high-density Hong Kong to low-density Managua. Many are still skeptical that agriculture can pay urban land rent and that it is appropriate to provide urban infrastructure for agriculture. As discussed in Chapter 4, however, the legality of tenure rather than land availability or the competitiveness of farming are the main problems.

Urban agriculture is an economical use of land for a number of reasons. Urban agriculture:

- generates income from temporarily available land at the growing urban periphery and the renewing core;
- puts idle water bodies, wetlands, and steep slopes to productive use and maintains the land (Case 7.7);
- generates income from idle, unbuilt parts of oversized facilities such as hospitals, factories, military bases, and airports;
- is a compatible open-space use in parks, sports facilities, universities, roadside verges, utility rights-of-way, riparian and floodplains along rivers and bays, cemeteries, and other locations;

- is a competitive land use in many cases (for example, poultry farms and ornamental horticulture on the outskirts of cities); and
- generates a considerable number of jobs for the relatively little land it requires.[39]

Case 7.7 Using old garbage dumps to grow vegetables in East Calcutta

Calcutta, India has some of the most outstanding waste-to-farming systems in the world (Case 3.5 describes the wastewater-based fisheries). At Calcutta's main garbage dump, the Municipal Corporation leases about 800 hectares of former dumping plots with rich compost for intensive farming. Small-scale farmers and cooperatives produce 150-300 tons per day of up to 25 varieties of vegetables which fetch high prices in Calcutta. The intensive farming generates employment for about 20,000 people.

The site is fingers of land jutting into a series of ponds east of the city, formed over time (since 1874) by building up ridges of land with ponds between them. The fields are served by unpaved roads. Farmers provide their own security by rotating night duty. The farming system is labor-intensive, including hand-carried irrigation water.

All inorganic reusable materials are removed from the garbage by an informal recycling industry at the source before the waste gets to the dump site. What remains in the mature sites is some unusable inorganic materials (such as construction debris and — increasingly — plastic) that the farmers clear from the sites. The remaining organic substrate is rich in nutrients, and no chemical fertilizers are needed or used (although pesticides are). Newer garbage is mixed into the soil, after one week for fermentation. This traditional farming is environmentally sustainable, and no significant problems of vegetable contamination has been identified.

Produce is sold to middlemen at the farm gate and to city center markets. Rent is paid to thika tenants, or landlords, who lease large tracts from the Calcutta Municipal Council. The West Bengal State Department of Agriculture provides monitoring and tests for food safety.

Contact: Christine Furedy (see Appendix F for complete address).

Where the entrepreneur is using land solely for farming, it is likely to be a competitive land use. Where farming is a second use of the land, the opportunity cost of using that space for farming is much lower than the economic land rent. In the case of utility rights-of-way and public facilities (such as airports) where land is held for future expansion, urban agriculture is mutually beneficial to the facility owner and the farmer.

The economics of urban land change when urban agriculture is added to the mix of land uses. The usufruct principle — an additional productive use can be added to land insofar as it does not deny the current or future owners the benefits of ownership — plays a vital role here. The application of this principle increases the total rent that is available. Thus public and private organizations with excess space in their establishments can earn a second income by renting space to farmers. Airport buffer and expansion areas can be farmed extensively for many years. In Jakarta, land under the elevated highways is leased to farmers. In West Bengal, the highway authority leases roadside land to rice farmers.

Urban agriculture may reduce the maintenance costs for public and private facilities, for example, roadsides and parks can be put to productive use rather than being mowed.

CERJ, the electric utility in Rio de Janeiro, has long made the land under transmission lines available to farmers. In the early part of the century, CERJ leased the land, mainly to Portuguese immigrants producing for subsistence. More recently, the company would give the land out on a permit or loan-contract (with no charge). These permits have clauses obligating the farmer to keep the area under cultivation, fenced, and without tall vegetation. Permits help the farmers receive credit as well as technical and training assistance from government agencies. One-third of the farmers produce mainly vegetables to sell, with the utility buying some of the produce for its canteens. For CERJ, this arrangement ensures maintenance of the land under the lines and prevents squatting.[40]

Sustainable Urbanization

Cities need to close the open loop of 'resources in, partial consumption, garbage out'. In an open-loop system, natural resources, some as inputs to production and some as consumables, are imported into urban areas and the remainder dumped as polluting waste **(Fig. 7.2)**. To improve sustainability, cities and towns must diminish the 'throughput' of resources.

A number of definitions of sustainable urbanization have evolved since the 1992 Earth Summit in Brazil. The authors agreee with Herbert Girardet:

> *A sustainable city is organized so as to enable its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future.*[41]

Clearly several urban systems and their interface with rural systems must be managed holistically. A human settlement will not perpetuate itself as a complex element in the natural ecology of its region unless all its systems are synchronized to that end — social, political, economic, food, infrastructure, etc.

Urban agriculture contributes to closing the open loop by re-using and transforming by-products and waste from other industries **(see Fig. 1.1).** Urban farming increases local production, reduces imports, and decreases the amount of discarded waste.

Since the 1960s, a number of models of ecologically sustainable human settlements have been proposed and sometimes tested in small experimental communities. These include the 'organic house' (Berkeley, California), the 'edible landscape' (Eugene, Oregon), 'eco-ville' (Yoff, Senegal), and 'Auroville' (Tamil Nadu, India). Other approaches to sustainable urbanization now being considered emphasize trees, recycling, reduced consumption, and infrastructure efficiency. Urban agriculture is integral to all these models and incorporates certain features from each one. Unlike these models, however, urban agriculture has emerged from a multitude of practitioners around the globe rather than through a theoretical construct, and it adds an economic dimension to the nutritional and environmental contributions of these models.

Sustainable urban agriculture is probably a prerequisite to both sustainable urbanization and sustainable agriculture. Sustainable agriculture has particular importance to low-income countries and communities that reside in a state of food insecurity. This is because low-income producers often cannot afford the costly inputs of

industrial agriculture, nor can they acquire credit to buy these (often ecologically unsustainable) inputs. And this in regions where the sale price of farm produce is a fraction of the world price. In an inland town Africa, a package of insecticide or fertilizer costs twice as much as the same product in New York or Rome. It is feasible for low-income communities to gain access to urban solid waste and wastewater as a means to improve and irrigate the soil.

Urban agriculture contributes to the ecological sustainability of cities by (a) enhancing the environment, (b) improving urban management, (c) contributing to waste management, and (d) conserving resources.

Environmental Enhancement

In most low-income countries, rapid urban population growth and unmanaged expansion are degrading the environment of not only cities, but also their surrounding regions. The result is polluted air, water, and soil; increased temperature; soil erosion; sharply diminished biodiversity; and increased vulnerability to disasters such as floods. Urban farming can not only reduce the negative environmental impacts of urban growth, but can even help improve the urban environment.

The environmental health benefits of urban greening (including crops and particularly agroforestry) include:[42]

- enriched biodiversity,
- habitat for wildlife,
- microclimate modification,
- reduced temperatures,
- increased humidity,
- improved air quality,
- reduces vulnerability to disasters,
- landscape enhancement,
- sense of well-being,
- site for physical exercise,
- shade and shelter from sun and rain, and
- noise reduction.

Biodiversity

Agriculture can provide greater biodiversity than many other urban land uses. This assertion is based on agriculture's contribution to a rich healthy soil, a range of crops and livestock, and the insects and birds supported by agriculture.[43] Its contributions are greatest when conceived in partnership with other urban improvements that lead toward more sustainable, 'greener' cities.

Producing food in the city conserves biodiversity in the countryside. Urban farming can produce 5-15 times as much per acre as rural farming. Consequently, it is not

unreasonable to perceive each community garden plot and backyard garden as conserving an area 10 times as large in a remote rain forest or mountain range.

Farming in the city often converts packed soil to loose, open soil while in other cases, it converts pavement and rooftop to soil. Soil is the most biodiverse material in the biosphere. Open loose soil cleanses water and promotes plant growth that cleans the air.

Fruit and vegetable crops often replace lawns or other grass-covered sites. Grass is a form of monocrop, which sheds rather than absorbs water. Soil under grass is frequently low in biota.

Some forms of urban agriculture such as ornamental horticulture may have the greatest potential to expand biodiversity, particularly the breadth and quantity of native plants. In general, urban horticulture is likely to be more diverse in its cropping patterns than commercial (largely rural) agriculture, given more direct access to the varied urban market (Case 7.8).

Case 7.8 Diverse edible landscape at the site of a factory near Brisbane, Australia

Andrew Christie wished to take a bold approach in landscaping the site of Neumann Steel, a factory he manages located in a conventional industrial area at the outer edge of Brisbane. He hired Steve Cran, a permaculture designer, to introduce some food plants and permaculture designs around the factory. He then introduced Cran to another manager, Wayne Dugdale, who felt that the company's new distribution warehouse at another suburban location could do with an even more ambitious transformation.

As a result, Cran was able to change one-half hectare of compacted clay land into a food forest. The metamorphosis was very rapid. Within a week of meeting with Dugdale, and with the aid of two helpers and a bobcat, Cran had already implemented changes to the landscapes. He created a food forest with a pond containing fish, edible plants, and an 'herb spiral' **(Fig. 7.3).** The spiral was made of sandstone blocks and measured 2.3 meters in diameter and 1.2 meters high. Chickens and bees were introduced at a later stage.

[insert here new Figure 7.?: General layout of fruit forest at Neumann Steel warehouse, Marsden, near Brisbane, Australia]

Fragrant herbs border the forest's paths. Twice as many types of leguminous trees and shrubs were interplanted among 30 types of trees. Cran placed the taller trees on the south side and lower trees on the north to allow good solar access. He planted native trees in the poorer surrounding soils. A pergola with lush vegetation of bananas, tamarillos, and pawpaws creates a rainforest effect and provides a cool area for workers to eat their lunch. The beds are mulched with a mixture of tree mulch, rock dust, and chicken manure.

Not only were the workers thrilled with the garden and help maintain it (and of course reap its fruits), but it inspired many of them to start gardens at home. The managers and workers of the original factory also stepped up conversion of that site's 'landscape' into a food forest by

volunteering after hours. Clients are also astonished and even bring family and friends back to visit.

Contact: See source listed in Appendix C.

Urban agriculture has the capacity to conserve and enhance biodiversity where we live. This potential is multifaceted. In addition to the benefits already mentioned, other benefits include:

- Organisms living in the soil have access to oxygen because the soil surface is open, rather than compacted, paved, or roofed, and rain is absorbed into the soil instead of running off with silt.
- Soil is frequently enriched through the addition of organic waste, which is readily available in urban areas.
- Plant and related insect and animal life are promoted through the reuse of nutrient-rich wastewater.
- By mitigating air and water pollution, urban farming enables biodiversity to thrive more easily in urban environments.

Improved Climate and Associated Energy Savings

It is now well established that trees have an ameliorating effect on the immediate local climate. Urban forestry improves a microclimate through cooling, and in the case of arid climates, increased humidity. Radiational heating, which creates urban 'heat islands', is greatly reduced by the presence of urban trees.

Chinese planners have for many years planted trees in cities for climate control and claim to have attained significant success. In Nanjing, an industrial city of over 1.5 million, 23 trees per inhabitant were planted between 1949 and 1981. The trees were planted on degraded hillsides, windbreaks, and along rail lines and streets in order to reduce summer temperatures and improve air quality. An average drop in summer temperature from 32.2 ºC in 1949 to 29.4 ºC in 1981 has been reported — and attributed by planners to the tree planting.[44]

Trees keep their surroundings cooler in the summer by providing shade and evaporating water from their leaves. Tree cover reduces the cost of summer cooling and winter heating. In California homes with tree cover but no air conditioning, inside temperatures were cooler by 20 ºF in summer. It is estimated that the cost of air conditioning a building can be reduced by 50-60 percent with planned tree cover.[45] In studying the effects of urban vegetation on a city environment, the Chicago Urban Forest Climate Project estimated that shade, lower summer air temperatures, and a reduction in wind speed by increasing tree cover by 10 percent could lower total heating and cooling energy use by 5-10 percent annually.[46] These temperate climate figures from Chicago would clearly be even higher in tropical cities such as New Delhi and Lagos.

American Forests, a non-profit organization, developed a method of urban ecological analysis (UEA) that measures the economic value of the ecological benefits of urban green in conserving energy, reducing storm water run-off and peak flow, improving air

quality, and maintaining wildlife habitats. A UEA in Atlanta, Georgia and 10 surrounding counties estimated annual saving in cooling costs of US$ 4.6 million, a cost reduction of about 35 percent in mitigating the effects of storm water (resulting in savings of US$ 1 billion), and indirect savings in air pollution management of US$ 3.4 million.[47] However, energy conservation through strategic planting of trees — and particularly fruit trees — is seldom deliberately included in urban housing projects in low-income settlements.

Fuel Production

Eighty percent of Africans use wood for energy, which is about 65 percent of the fuel they consume. Current trends indicate a three-fold increase in demand for fuelwood by 2020, creating the potential for serious shortages. More than 50 million Africans already face shortages. In 2000, urban populations accounted for 50-75 percent of fuelwood demand in most countries in the region.[48] If the urban bioregions are not to be destroyed in the ever-expanding search for wood fuel, managed forestry in urban and peri-urban areas is imperative.

Some countries already manage urban forestry for energy and other uses, but the practice must be expanded and improved. The Bandia forest in the Dakar-Mbour-Thies triangle in Senegal has been managed for fuelwood production since 1950.[49] Burkina Faso has managed the natural forests near Ouagadougou for fuelwood since 1981. Many towns in sub-Saharan Africa have had green belts since the 1970s — plantations of eucalyptus around Ouagadougou, mixed forests of timber and fuelwood around Bamako, eucalyptus and other plantations in peri-urban Niamey, and neem, rosewood, cailcedra, and acacia plantations around N'Djamena. The African Development Bank is funding a project to better manage fuelwood production for Addis Ababa (Case 7.9).

Case 7.9 Fuelwood from peri-urban plantations in Addis Ababa

With a growing need for wood fuel and construction timber, deforestation in the hinterland of Addis Ababa became an increasing problem. Eventually, a system of controlled harvesting of the nearby natural forests was introduced. Eucalyptus plantations were also introduced around the city, and each resident was required to plant and tend 100 seedlings.

This private ownership of eucalyptus plantations continued until the 1974 revolution in Ethiopia, after which the State took over forest ownership. By this time, some 20,000 hectares of plantation had been established by private growers around Addis Ababa. These came under control of state agencies, urban dwellers' associations, and peasant associations, and were rapidly exploited in an unplanned manner. Estimates based on satellite imagery indicate that in the 3-year period 1973 to 1976, the peri-urban plantations of Addis Ababa decreased by 33 percent.

Addis Ababa is now a city of several million people and continues to have a heavy demand for fuelwood and construction timber. The bulk of the former is supplied from forests and plantations within a 100 kilometer radius of the city. Efforts to improve fuelwood supplies have brought to attention the large number of fuelwood carriers and their families who depend upon this work for their livelihood. Collectively, they supply Addis Ababa with about one-third of its fuelwood requirements.

In recent years, the government of Ethiopia has taken steps to improve wood supplies to Addis Ababa through programs to upgrade the eucalyptus plantations in collaboration with international donor and lending organizations such as the World Bank and the African Development Fund. A draft forest policy aims to reintroduce private forest ownership.

Contact: See source listed in Appendix C.

Abatement of Air Pollution and Dust

Most large cities in developing countries are suffering from air, water, soil, and noise pollution. In Latin America, some 30 million children, 47 million adults ages 15-59, and 4 million elderly were estimated to be exposed to air pollutant levels that exceeded WHO guidelines.[50] The Parks Department in Jakarta has attributed lung-related diseases among 29 percent of residents in part to limited green cover in the city.[51] Air problems are increasing dramatically with the growth of large cities and industry. In Mexico City, particulate suspension rose from 65 milligrams per cubic meter in 1974 to 400 milligrams per cubic meter in 1990, and atmospheric sulfur dioxide rose from 60 to 120 milligrams per cubic meter.[52]

Negative health effects range from mild irritation to serious cardiorespiratory diseases. They are caused by sulfur dioxide and particulates from fossil fuels, photochemical oxidants and carbon monoxide from motor vehicles, and miscellaneous pollutants such as hydrogen sulfide, lead, and cadmium emitted by smelters, refineries, manufacturing plants, and vehicles. The Inter-American Development Bank found that planting and maintaining trees would cost one-half as much as adding effective pollution controls on Mexican vehicles that would clean the air an equal amount.

While tree and vegetation cover alone cannot solve the air quality problem, the cover certainly helps ameliorate the situation by reducing the concentration of pollutants and suspended particulates. Urban agriculture cleans the air by reducing dust and absorbing pollutants through its foliage. In arid areas, tree belts shelter settlements from sand and dust, such as in the greenbelts around Ouagadougou and Nouakchott.[53]

The Chicago study mentioned above determined that trees in the Chicago area removed some 6,145 tons of air pollutants in 1991, providing air cleansing valued at US$ 9.2 million. The trees sequestered approximately 155,000 tons of carbon per year and provided energy savings in residential heating and cooling that in turn reduced annual carbon emissions from power plants by about 12,600 tons. The projected net present value of investment in 95,000 trees in Chicago is US$ 38 million, indicating long-term benefits that are more than twice the cost. These benefits accrue to all portions of the city, especially those that include urban forestry.[54]

Other Enhancements to the Environment of Settlements

In developing countries, environmental quality is usually lowest in low-income residence/mixed-use areas of cities:

- These neighborhoods are often crowded and located on land that is ill-suited to human habitation.
- The level of urban services is generally low.

- Low-income areas are often 'dumping grounds' for other portions of the city.
- Sanitation and hygiene are poor, increasing the incidence of diarrheal and respiratory diseases, as well as pests such as rodents, houseflies, and cockroaches.[55]

Farming in low-income communities has the potential to improve environmental health. If properly managed, it can turn unsightly lots into neatly cultivated areas, improve sanitation by reusing solid waste and wastewater in farming, regenerate soil by returning organic material and microbes, and reduce air pollution through greening (Case 7.10). Farming and trees in the slums also reduce the vulnerability of the community to disasters such as floods and landslides.

Case 7.10 'Productive ecological settlements' in Ajusco, Mexico City

Ajusco is a forested, rocky region southwest of Mexico City where squatter settlements developed along the highway in the 1950s. By the 1970s, the area had become heavily degraded and polluted. The government, landowners, and the real estate industry made repeated attempts to evict the squatters from the region. In 1980, the area was zoned by the city government as a 'green' zone. The decision was made to evict the settlements, restrict development, and reforest the area to restore the ecological balance, reduce pollution in the city, and replenish groundwater aquifers.

To resist eviction, some squatter settlements decided to cooperate in the greening efforts and create ecologically sustainable settlements. The communities organized themselves and implemented programs of tree planting, vegetable gardens, and pollution control. University biologists and environmental NGOs (particularly the Group of Alternative Technology) provided assistance.

The local group 'Bosques del Pedregal' proposed an initiative in 1984 to fight diseases affecting the forest, protect all vulnerable trees in the settlement, reforest the Bosques Zone with 20,000 fruit trees and 20,000 other trees to improve air quality, and establish composting facilities in order to create an integrated 'productive ecological settlement' through reforestation, microlivestock, fisheries, mushroom farming, and horticulture. The settlement had already planted more than 5,000 trees. As part of an integrated recycling system, compost and rabbit waste were used to fertilize trees and vegetables.

The conservation and pollution-control efforts of the settlements convinced the Mexico City Federal District to adopt such activities as part of its ecological plans for the area and allow the settlements to remain in the zone. The concept of ecological zones around Mexico City continues today.

The Inter-American Development Bank is helping the district to prepare plans for two other mountainous areas (Guadalupe and Santa Catarina) at opposite sides of the valley enclosing much of Mexico City, with a particular focus on sustainable reduction of air pollution. As part of this effort, the bank has conducted cost-benefit assessments that found peri-urban reforestation to be an economical investment compared to other pollution mitigation techniques.

Contact: See source listed in Appendix C.

Along stream banks, waterways, and other fragile areas, tree planting not only reduces vulnerability to flooding and landslides, but also protects against soil erosion and siltation while producing timber and firewood.[56] Instead of lining canals with concrete, lining with trees is a cheaper solution and a better use of seepage water. This approach has been successful in Egypt, India, and China.[57]

The combination of environmental improvements can be illustrated by the residents of the slum of Kitui-Pumwani in Nairobi, and by the Undugu Society, a local NGO that helped them set up community projects. The residents created a banana plantation to protect from flash floods and produce income from the bananas. Household waste is composted and added to the soil, which also solves a waste disposal problem. The Undugu Society also promotes the use of local organic pesticides instead of imported chemicals.[58]

Several cities in Sweden, the Netherlands, Japan, and the United States have urban farming and forestry strategies. Trees on lots that are reserved as green space or planted along streets are common throughout the world. Only a few cities, however, such as in Bangladesh, India, China, Chile, Argentina, and Senegal, plant trees that produce an income through fruit, fuelwood and other tree products.

Trees and vegetation also help reduce noise pollution, one of the stress factors in urban living, by absorption, deflection, reflection, refraction, and masking of sound. Mexico City has high noise levels near major highways and the airport. Prolonged exposure to such noise levels can damage hearing. Trees are believed to selectively absorb higher frequencies and can measurably reduce noise.[59]

The environmental benefits of urban agriculture are substantial. But when poorly practiced, urban agriculture degrades the environment. Its potential negative effects are addressed in Chapter 8.

Efficient Urban Management

To date, the role of urban agriculture in managing towns and cities has been little studied. Urban farming can contribute to more efficient urban management — its benefits can help city managers overcome some of their most vexing problems, particularly in low-income areas.

In most low-income neighborhoods, open spaces of many kinds attract refuse and are unhealthy. Urban agriculture can clean and maintain them, produce food, green them to improve the quality of the environment, and help free them of anti-social behavior — all at very little cost to the municipality. The improved appearance of these sites is invariably a source of community pride. More generally, properly maintained urban agriculture can be a visual asset to any site, as the example of the Australian factory made clear (Case 7.8).

In some situations, urban agriculture enrolls the poor in urban management. Lower-income groups assume responsibility for the environmental quality of their own neighborhoods when they are provided the means to do so and if they get a good economic return on their labor.

Community- and city-wide farmers' associations, whose formal status and ties to the municipality may vary, contribute to management of riparian rights, land use,

environmental quality, food quality, and processing and marketing of food products. Urban farmers enhance security in the community as they protect their crops.

Large and small cities throughout the world include urban agriculture in their package of management tools. In São Paulo, for example, land-use regulations encourage intensive farming on utility rights-of-way. In Mexico City, land and water farming are part of the city's industrial and open space plans. Shanghai and other Chinese cities have in the past been self-sufficient in vegetable production by promoting managed farming (see Case 6.4). In Bangkok, vacant factory sites are routinely rented on a short-term basis to small-scale farmers. In Dar es Salaam, floodplains within the city are intensively farmed by well-organized farmers' associations. Since antiquity, Rome has allowed livestock grazing under usufruct arrangements to efficiently manage its open spaces **(photo 7.11).** In Rio de Janeiro, where periodic mud slides in slums on steep slopes result in hundreds of deaths, the state government has initiated a forestry program to hold the soil and provide incomes for residents.

Field visits, interviews, and published sources suggest that many Asian cities manage urban agriculture relatively well, as do some European cities. Latin American and African cities generally have less well-organized systems and procedures to manage urban agriculture. One of the outstanding exceptions is Bulawayo, the second largest city in Zimbabwe (Case 7.11).

Case 7.11 Urban management and urban agriculture in Bulawayo

Urban agriculture in Zimbabwe, especially cultivation of staple food crops by urban households, is as old as the human settlements themselves. The practice of farming in urban areas is undertaken by people from different social and economic groups for varying purposes. Cultivation by the poor, who are the majority of the urban population, dominates. Urban agriculture is practiced under different circumstances and arrangements.

In Bulawayo, urban agriculture is getting positive recognition and attention. As a follow-up to Agenda 21 set forth at the Rio Earth Summit in 1992, the City Council convened a group of officials to study urban agriculture with the goal of formulating a policy for its development. The City of Bulawayo master plan has zoned a number of areas for residential and agricultural purposes. The food produced is readily marketed in the city through the many wholesale and retail outlets.

The most prevalent urban agriculture activity is cultivation occurring in areas not zoned for this use — in particular areas earmarked for future urban development. Whenever the local authority has acquired land that sits idle, it is occupied and cultivated until urban development takes place. Even if the vacant pieces of land are surveyed and serviced, as long as there are no structures, they are cultivated. The people occupying the land are well organized, using the same piece of land for many years. The fields are usually worked by women and children, and tillage by hoe is the most common method of cultivation.

Some low-density suburbs have tended to maintain their agricultural activities, which is perfectly legal if they have user rights that include farming. Garden allotments have been established in selected areas of the city, particularly in the relatively fertile areas along water courses. These allotments are mainly set aside for the destitute who grow vegetables for subsistence and sale. Market gardening and poultry can be allowed in some residential properties of reasonable size, as well as in some open spaces, through special consent of Council.

Women's groups, youth groups, cooperatives, and other groups wishing to engage in urban agriculture are encouraged to identify suitable sites for their activities.

Contact: J.J. Ndebele (see Appendix F for complete address).

Urban agriculture that is not well managed and monitored can spawn diseases and pollute land and water. Therefore, changes in administrative organization and operations are required when urban agriculture is introduced or expanded within a city. For example, governments may need to impose certain land-use regulations on agriculture near industrial sites and along highways, permit only selected crops to use wastewater irrigation, or prohibit certain fertilizers and insecticides near residences, hospitals, and schools. Standards that are useful in setting such regulations are available from the Food and Agriculture Organization and the World Health Organization, among others.

Waste Management Benefits

From the earliest times, urban settlements have incorporated farming that uses organic waste generated by the settlement. Maps of walled medieval cities show sizable areas within them being gardened, in addition to intensive horticulture and livestock beyond the city gates. Urban wastes were delivered to these sites by oxcarts and handcarts. Similar waste management systems were practiced — and continue in some measure — in China, Egypt, Mexico, India, and Singapore. The reuse of wastewater has also long been customary.

In Almaty, Kazakstan, with the support of the International Center for Agricultural Research in the Dry Areas (ICARDA), urban waste water is treated and stored in a reservoir of over 1 million cubic meters, and over 6 square kilometers. This resource is used primarily for industrial, forest, and fodder crops. Currently fish production is being initiated as a protein source for livestock.

During the rapid urbanization of the late 19th century, urban farmers paid good prices for the waste from slaughterhouses (hides and bones). They competed for access to the manure of draft animals, and composted waste of many kinds.[60] A large share of waste management in small and large cities was in the private hands of market and truck gardeners.

During the 20th century, by contrast, in most countries influenced by the European and American style of development, urban waste management and agriculture have been separated into the public and private sectors with relatively little interface — municipalities and special waste management districts deal with waste and private farmers raise food, generally with no access to urban waste as inputs. At the same time, farmers have moved away from waste toward agrochemical inputs to nourish the soil.

During the last third of the 20th century, however, many parts of the world have generated models of efficient, sanitary, and ecologically sound waste management systems that can place this essential urban function inside the community. It is as feasible at the beginning of this century, as it was in the year 1900, for a family, apartment building, restaurant, or university to contribute to the economy, ecology, and food security of its immediate community by the way it manages waste.

Most cities today face acute problems in managing their waste. In the USA, food waste is the third type of urban waste in total weight (after yard waste and paper). Solid waste dumps are piling up, and landfill space is fast running out, yet less than 3 percent of food waste is recycled.[61] While this is an extreme example, similar patterns can be found in many other countries in the North and South. Sewage discharge is polluting ocean estuaries, bays, rivers, and groundwater. Wastewater and solid waste collection systems are costly for a city administration, and most municipalities in developing countries do not currently have the capacity to serve an entire city. As a result of inadequate waste collection and processing, waste decomposes on the streets, causing pollution and putting the public health at risk.

The use of biological waste in urban agriculture has many advantages. It contributes to natural resource conservation, turns waste from a problem into a resource, reduces the public cost of waste management because the private sector gets involved, and provides a better living environment, especially in areas not receiving waste management services.

A sustainable future for cities would require a move toward technologies that transform waste into useful products rather than dump it. Urban farming can contribute to this process in several ways — by producing crops for human and livestock consumption, composting, and processing wastewater for direct production and irrigation. Some examples are listed in Table 7.4.

For centuries, farmers the world over have used composted organic waste to fertilize and enrich soils and as a form of pesticide. Some city governments, such as Shanghai (Case 7.12) and Jakarta, have developed citywide programs to collect, compost, and sell organic waste. Similarly, a number of cities — in Germany, Israel, Jordan, Mexico, Morocco, Tunisia, and California in the USA — use treated wastewater for irrigation of urban and peri-urban crops. Urban density and relatively cheap transportation should make decentralized solid waste management that is intended for reuse in urban farming more and more practicable and accessible.

Many farmers prefer wastewater over freshwater or groundwater because of the nutrients it provides to the soil. Use of wastewater for irrigation at a significant scale is now a common practice in countries as hydrologically diverse as Tunisia, Mexico, Jordan, and Singapore.[62] Recent technological advances are improving the benefit of this principle at the same time as water shortages are growing in one-third of the major river basins on Earth. [63]

A very promising use of urban farming is biological treatment of sewage ponds and wastewater-contaminated lakes with aquatic plants such as duckweed and water hyacinth (see Case 5.4). These crops purify the water and are commercially useful as high-protein animal and fish feed. This technology is being used with profitable results in Bangladesh, India, Mexico, and the USA.

Table 7.4 Benefits of urban agriculture on waste management

Country	Impact
Solid waste management	
Africa	
Sudan	Approximately 27 percent of all garbage in *Khartoum* is consumed by urban animals such as goats, sheep, and cattle. These animals are also a valuable source of income and nutrition for poorer families.
Asia	
China	In *Guangzhou*, nine crops are produced each year on open sites using nightsoil and urban compost.
India	In *Calcutta*, 800 hectares of mature dump land produce an average of 150-300 tons per day of vegetables without the use of chemical fertilizers.
Europe	
Sweden	In *Vasteras*, a waste composting room is provided at the entrance to all residential blocks. Some of the compost is applied to community gardens.
Latin America and Caribbean	
Brazil	*Curitiba* provides solid waste compost to urban farmers. The waste is delivered by citizens who receive vouchers that they can exchange for food.
Argentina	*Rosario* is promoting organic waste recycling for community farms, rooftops, and household plots.
Ecuador	*Cuenca* is providing processed organic waste products to family farms and school gardens on public and private land.
Wastewater management	
Africa	
Tunisia	In *Tunis*, 1,750 hectares (mostly forage) are irrigated with treated wastewater.
Asia	
China	In *Shanghai*, 8,000 tons of nightsoil and seepage are collected each day (about 90 percent of the city's human waste). After treatment, the waste is sold to farmers in the urban region.
India	The 3,000 hectares of *Calcutta's* sewage-fed lagoons produce an average of 6,000 tons of fish each year.
North America	
USA	Two hundred wastewater reclamation plants throughout the state of *California* save 759,000 cubic meters per day of fresh water, with most of the treated effluent put to agricultural use.

Source: Data compiled by The Urban Agriculture Network from various sources.

Case 7.12 Producing organic fertilizer from urban waste in China

Organic waste, including nightsoil and solid waste, has traditionally been used by Chinese farmers to fertilize soils. In several Chinese cities, the waste management systems are organized to recycle urban organic waste for use in the production of vegetables, fruit, and animal and fish feed.

Waste is collected by a municipal corporation (and sometimes by farmers in the city's vegetable-growing communes). The municipal corporation usually manages the allocation of the waste, for which the communes pay. The fermented soil is added to other organic matter to make compost or is spread directly on the soil, away from the crop. Organic waste from the city is composted in the countryside or in municipal composting plants and sold to farmers. It is also used as an input to pig and fish feed.

In Shanghai, the Bureau of Environmental Sanitation collects most of the city's human waste. Nightsoil and seepage from public toilets, septic tanks, and dumping stations are collected and shipped out of the city daily in sealed barges. The waste is composted for 10-30 days, sometimes with other matter such as dead plants, and then sold to farmers as fertilizer. Repeated usage has proven the waste to be a safe fertilizer.

The Shanghai Resource Recovery and Utilization Company produces a range of products from the material it recycles from the city waste. The company maintains a network of 500 purchasing and processing centers throughout the 10 towns of the metropolitan municipality. The process (collection, transportation, and processing) is labor intensive but efficient and profitable.

Until recently, Shanghai disposed of all its municipal waste through farming. The system has begun to break down, however, since the Chinese government began to subsidize chemical fertilizers.

Contact: See source listed in Appendix C.

There has been a recent reawakening of interest in 'ecological sanitation' — urban sanitation processes that do not use chemicals or large buildings and equipment to process human waste. The application of ecological sanitation, which separates urine from feces and treats each with different processes, has significant improved health and environment possibilities. Urine is sterile and contains most of the fertilizing benefits of human excreta. Collecting and treating urine at the community or settlement level and applying it to urban agriculture can provide one-half or more of the nutrients needed to produce the food the community consumes. With adequate oversight, composting human feces, can improve the soil and local ecology. Composting toilets are being promoted by private and public organizations in diverse countries, ranging from Sweden to Mexico and Zimbabwe. The environmental and food security implications of ecological sanitation are under study.[64]

Despite these examples, relatively few cities in the world have waste management systems that are organized to comprehensively reuse waste, let alone process it as an input for farming. Most recycling, including use of waste in farming, is in the informal sector.

Unregulated waste management, especially by individuals, has its dangers, as discussed in Chapter 8. However, managed at the community level, waste recycling and composting can improve a waste management system and increase the service in more

parts of the city, while reducing or avoiding municipal costs. This is being demonstrated through research in Indonesia by the Harvard Institute for International Development[65] and at Cheikh Anta Diop University in Dakar, Senegal.[66]

Africa may benefit the most from transforming its waste into useful products, precisely because the present formal waste management infrastructure is generally so underdeveloped. Africa has the poorest soils and the least developed systems to serve urban areas with rural food products. The lack of prior investment in landfill-based waste management may be turn out to be a key factor because urban waste can be used as an input.

Resource Conservation

The relationship between urban agriculture and resources is multifaceted. The potential role of urban farming to transform urban waste into useful agricultural inputs and make productive use of otherwise idle land has been discussed. This chapter has also shown how *human resources* (individual energy, availability, knowledge and skills, as well as the wealth of community collaboration) and *economic resources* (especially through fungible income that is tapped for other basic needs) can be used productively.

Both land and water are conserved by farming in urban areas compared to rural areas. Urban farming conserves resources by reducing the pressure to convert deserts, mountain slopes, and rainforests into cropland and cut woodlands for fuel. As we face oceans bereft of fish, appropriate aquaculture around cities has a major role to play in reducing overfishing and maintaining biodiversity in the oceans by producing fish on land and reducing pollution.

Urban agriculture methods are intensive, therefore products are produced on a fraction of the *land* needed for rural production. Cultivation on small farms, as is characteristic in cities, produces several times more output per unit of space, as shown in a survey of 15 low-income countries as well as in the USA.[67]

Urban agriculture is also parsimonious in its use (and reuse) of *water*. The International Water Management Institute reported in late 1999 that one-half of the earth's 500 largest rivers are being depleted and/or polluted.[68] The largest source of both depletion and pollution is agriculture. Urban farming can not only conserve water, but clean it as well. Capturing rainwater from rooftops and paved surfaces and collecting it in cisterns for vegetable irrigation, or reusing the same wastewater for irrigation one or more times, is many times more effective in a dense urban settlement than in a rural setting. Urban farming is less vulnerable to water shortages than rural farming because more varied sources (particularly reused urban wastewater) are available.

A number of farming systems and techniques that are particularly prevalent in urbanized areas (including the peri-urban belt) — from the cultivation of mushrooms to hydroponic greenhouses — require little water. Modern drip irrigation uses one-eighth to one-quarter as much water to produce vegetables as the overhead sprinklers that are characteristic of commercial extensive agriculture. Biointensive raised-bed production uses a small fraction of trench irrigation. The use of plastic to cover the soil or as a tunnel

reduces transpiration by 50-90 percent, depending on the crop and climate (wind, temperature, humidity). Multicropping and careful selection of crops, as commonly practiced in urban agriculture, use much less water per unit of production, and also reuse water that has been utilized by other urban activities.

Soil depletion is also a global phenomenon. *Soils* migrate down rivers or into the wind in areas of both rich deep soils and poor shallow soils.[69] Certain crops are associated with the highest rates of soil depletion, indeed, some cynics maintain that soil is the leading export from some countries. Maize, largely a rural crop and often massively produced, is always at or near the top of the list. On the other hand, multicropping — a characteristic urban practice —in most cases conserves soil.

Urban agriculture can contribute to resource conservation in yet another important way — saving *energy*. Earlier in this chapter, we discussed how home heating and cooling can be reduced through urban greening, especially agroforestry. Urban farming also helps to conserve energy by reducing the need for transportation and cooling.[70] The average pound of food in a supermarket in the USA travels an estimated 2,000 kilometers (1,300 miles) between its production location and its consumption location.[71] This average distance is cut to less than 100 miles when more food is produced locally, saving substantial fuel. Air cargo demands 14 times as much fossil fuel energy per mile per kilogram as the same distance by rail shipment.

In poorer countries, the distance saved with increased urban agriculture may not be as great, but the impact may be more beneficial since energy costs are higher in actual and relative terms, and the proportion of traffic that is moving food is greater. It has been estimated that in Port-au-Prince, Haiti, more than half the vehicles moving goods from the north to the city transport food.[72] The reduced traffic and potential savings in energy and transportation costs from increased local production are obvious. Not so obvious are the savings in storage (including cold storage) and product loss due to handling and transport.

We have already seen how urban production of fuelwood (for example, eucalyptus) can substitute for other, imported sources of energy or for fuelwood grown in more distant locations. Such urban production helps reduce agricultural expansion into rainforests, deserts, and other fragile ecosystems, while also cleaning the urban air. Crop residues are used for energy, and in India and many other countries, animal dung is commonly used as fuel.

Urban crops need less packaging because they travel for less time and over shorter distances. Even with less package protection, there are fewer losses due to handling and deterioration. These conservation advantages can be considerable in tropical climates.

Finally, urban agriculture transforms waste into food and thereby conserves petroleum (used to produce and transport nitrogen fertilizer) and the world's phosphate and potash reserves.

Disaster Prevention and Relief

Of all the potential benefits of urban agriculture, perhaps the least appreciated and understood is the contribution to avoiding disasters, mitigating their impacts, and

recovering from them. The disasters it bears upon can be of two general kinds — 'natural' disasters, and 'human' disasters. Urban agriculture can make two principal contributions —helping to prevent the occurrence or intensity of some disasters, and reducing the consequences of a range of disasters and other urgent situations.

Productive Use of Hazard-Prone and Sensitive Areas

Urban agriculture offers a productive use for urban areas that pose a high risk for natural disasters and that are expensive to build on, such as steep slopes and floodplains. Orchards and marketable grasses such as vetiver are excellent for reducing erosion and vulnerability to disasters in sensitive areas. (Case 7.13). Trees and grasses are particularly effective for holding steep slopes. Terraced crops are among the best ways to use such slopes, and managed forestry can supply the fuel and wood demands of a city.

Floodplains offer the opportunity to plant crops that need irrigation. In both fluvial and coastal plains, crops can be protected from floods by trees and grasses, with the latter feeding poultry and livestock.

Case 7.13 Cultivating vetiver for environmental and disaster control

Soil erosion on deforested hills, along waterways, and in conjunction with public works is a major problem in urban areas. It makes the land vulnerable to floods and winds and reduces the amount of available farm land.

Vetiver is a thick, tough grass that can withstand even tropical storms. The dense grass forms a wall against soil erosion and creates terraces on hillsides that can be farmed. The plant has roots 6-10 feet deep and coarse blades that rise equally high above the ground. The thick growth prevents water runoff, forcing the water to soak into the soil, thus making the land farmable and raising the water level of aquifers. Planted across a floodplain, vetiver can slow the force of floods and protect field crops. In Fiji, vetiver planted on a sugarcane plantation survived a storm that dropped 20 inches of rain in 3 hours.

Vetiver thrives in the tropics but can grow in any type of climate, humidity, and soil. It does not spread uncontrollably because it does not have runners or rhizomes and its seeds are usually sterile. Its growth and spread are easily managed.

Vetiver can be planted along public works — railroads, roads, steel structures — to prevent damage from washouts. It can also be planted along the sides of canals, bridges, and dams to prevent scouring. Vetiver has commercial uses and can be used for mulch, in animal pens, and to make ropes, hats, thatching, mats, and other woven items.

Contact: See source listed in Appendix C.

Urban agriculture is also a productive land use for hazardous areas such as airport landing approaches, utility rights-of-ways, highway shoulders, industrial zone peripheries, and solid waste dumps. For example, areas close to the Abidjan airport in

Côte d'Ivoire as well as both airports outside Paris (Orly and Roissy) are extensively cultivated. After closure, sanitary landfills and dumps require years to settle and become safe for residential or other uses. In all these situations, building in these areas can be an invitation to disaster, while farming can be an acceptable and economic use with many advantages that we have already enumerated.

Urban agriculture is an appropriate use on unstable soils such as expanding clays. A well-known example is the downtown area of Managua, Nicaragua that was hit by a severe earthquake in 1972. Because this area is highly susceptible to future disasters, it was not resettled, but instead planted to agroforestry and used as open space.

Mitigation and Relief in Natural, Civil, and Economic Crises

Urban agriculture can aid recovery from man-made and naturally caused disasters Farming can be a source of nutrition in refugee camps or cities cut off from their food supply due to civil strife. Although grain and cooking oil are generally provided by relief agencies, fresh meat and vegetables are always in demand and can be produced by the refugees themselves. Urban farming can contribute to survival in long-term conflagrations as well as in their aftermath.

As advocated by the working group on Agriculture in Relief and Transition (ART) in Washington D.C., emergency agriculture for refugees and internally displaced persons has several beneficial attributes over historically-provided food-aid rations. Emergency agriculture can:

- empower an affected population (particularly women, youth, and the elderly) to become nutritionally self-reliant;
- improve the quality of available food (adding protein, vitamins, and minerals to carbohydrates);
- make positive use of local ecology and beneficial use of its wastes;
- contribute to establishing a temporary 'camp economy', including jobs and trade, which supplements the local economy;
- diminish the total demand for outside assistance; and
- raise morale.

As noted earlier, urban agriculture is counter-cyclical to economic trends, flourishing in times of recession or depression and expanding as unemployment grows. Urban agriculture offers food security in times of economic and civil crisis by improving physical access to food and contributing to an informal economy. Food is characteristically the dominant element in an emergency economy. In a time of disaster — whether in terms of available jobs, income generated, or expenditures — food tends to become an even more dominant component of the economy than in a normal urban context. The jobs and businesses supported by urban agriculture in this situation are the foundation of the new economy. The emergency food economy may be barter, camp scrip, the local currency, or a mix of all three.

The capacity of urban agriculture to respond to war was well documented in European cities during World War II. A similar capacity persists today. Kinshasa,

Havana, Moscow, Baghdad, and Beirut survived crises during the 1980s and early 1990s by quickly turning to urban agriculture.

During emergencies, the number of urban farmers growing for their own families may increase. In some cases intensive commercial production may flourish, survive the emergency, and become a viable market activity (Case 7.14).

Case 7.14 Greenhouse farming in response to civil war in Beirut

Lebanon was the fruit and vegetable basket of much of the Middle East until its civil war, which started in 1975, fragmented the city and broke distribution channels for agricultural products. Each zone had to be self-contained, including its food supply. New farmers started cultivation for self-consumption. More importantly, horticultural methods had to be intensified, and the use of greenhouses became widespread.

Greenhouses made their first appearance in Lebanon in the mid-1960s, but for a decade, their growth was very slow so that only a handful of hectares were covered by 1975. The onslaught of fighting changed this situation, speeding their adoption, in particular along the coastal plain. By the end of the war, over 700 hectares were covered by greenhouses. While making up only 1.5 percent of the total market gardening area, they provided 18 percent of the produce.

Intensive commercial production not only flourished in coastal Lebanon during wartime, but outlasted the war to remain an active market activity even today. Indeed, by the mid-1990s, greenhouse surfaces had doubled to 1,350 hectares. While planted predominantly with a combination of tomatoes and cucumbers, shelters are also used for a wide range of fruits, vegetables and ornamentals. Greenhouses, plastic tunnels, and open-field cultivation today form a green patchwork that is interspersed among the ribbon of buildings that follows the Lebanese coastal plain. Dozens of greenhouses can even be found within the close suburbs of Beirut.

The expertise acquired in designing and constructing greenhouses has even become an export industry to other countries of the Middle East. Greenhouses not only played an important role for food security during the war, but also helped to sustain agriculture after the war.

Contact: Joe Nasr (see Appendix F for complete address).

In the 1960s when Indonesia faced severe hunger, farming in Jakarta was apparently common. The Agriculture Agency of Jakarta actively developed and promoted city farming programs to encourage people to farm all vacant land. The program was terminated and all farming licenses revoked in 1976, but it restarted in the 1990s in response to the economic crisis.[73]

When the economy and civil order collapsed in Zaire starting in the late 1980s, the largest city, Kinshasa, already had an urban agriculture farmers' association of some 6,000 members.[74] To reduce starvation, farming activity in the city expanded.[75]

And in Kampala, Uganda, residents planted the verges of streets and vacant lots to feed themselves and their neighbors during the Idi Amin era and civil war. In 1981 (after the civil war), UNICEF found that urban agriculture, a virtually undocumented phenomenon, was substantially feeding the city in non-cereal foods.[76] To date, there have

been no positive government interventions in Uganda, but there has been NGO support, including from the YWCA. Food production has persisted in times of peace, and the municipal administration is considering including urban agriculture in the new city plan. Makerere University has been studying the process, with some future possibility of influencing national policy.[77]

During the civil war following independence in Mozambique, the socialist government initiated urban agriculture through cooperatives in the green spaces of the capital and other cities. In one case, a colonial-era golf course was converted to irrigated rice production.[78] These 'green-belt cooperatives' have expanded beyond food production to health care, day care, and other economic and social enterprises.[79] In 1993, the African Development Bank made a low-interest loan to support agriculture in the 'green zones'.

Improved nutrition is a common advantage offered by emergency agriculture.[80] In the case of Liberian urban farming refugees, a study carried out by UNICEF at the end of four years found that the refugees had a higher nutritional status than the local population, which had poorer access to fresh vegetables.

Urban farming was not common in Havana before the mid-1980s. But by 1998, there were 8,000 recognized farming facilities with 30,000 farmers involved in popular gardens (huertas populares), intensive gardens (huertos intensivos), self-provisioning gardens (autoconsumos), small farms in the greenbelt (campesinos particulares), and state enterprises (empresas estatales), with some areas reported to produce about 30 percent of their food needs. Workers can find affordable food close to their homes outside the ration system.[81] Five years after the crisis-era urban agriculture program began, studies showed that children were eating four to five times as many vegetables per day as when the crisis began, and were healthier.[82]

Relief supplies are often unreliable and do not always provide a balanced diet, whereas locally-produced food can be more reliable and much more nutritious compared to typical emergency hand-outs. Urban agriculture is particularly effective in post-disaster situations because food can be accessed directly by consumers, and is not subject to choke points and vagaries of the market — and it helps counter food used as a weapon.

Agriculture in a temporary residence can have important links with waste management by reusing some solid and liquid wastes from the camp as fertilizer and irrigation. In some instances, this benefit goes beyond the camp's boundaries, with the temporary population providing assistance to the locals. In Côte d'Ivoire and Bangladesh, refugees not only collected and composted waste in their own quarters, but also collected waste from nearby settlements, to everyone's benefit. The presence of urban farming within and next to a refugee camp can also reduce the ecological impacts that remain once the camp is vacated.

Food production can be a learning experience for the victims of complex emergencies. The stress of being uprooted forces a population to learn new things quickly. Introducing intensive agricultural production benefits this population by teaching them some techniques of food production and greening that they can carry over into their post-displacement lives. They experience the complex process of food production, processing, and marketing while at the same time dealing with the special constraints of

supplies, tools, and market demands. The situation calls for creativity that is not demanded in a stable settlement to the same extent.

Urban farming is undertaken for different benefits by different interests. Farmers may be more interested in nutrition and income, while city administrators may be more attracted by environmental benefits, as may be communities living in environmentally degraded areas.

The practice and benefits of urban farming can be transferred across farmers and regions. In a place where middle-income backyard gardening is well established, the best practices can be moved to low-income community gardens and commercial market gardening. Where a large corporation is engaged in plantation vegetable production, production can be shifted to small-scale urban outgrowers. Greenhouse hydroponics can be transferred from large commercial operations to squatter area rooftops. This kind of expansion and diffusion can have a synergistic effect, expanding the number and kinds of benefits from any one activity.

Nevertheless, the benefits of urban agriculture do not come without risks and costs (to be discussed next). The risks of health problems and environmental pollution are greater than those for rural agriculture for two reasons — farming systems are more intensive, and their proximity to dense human populations makes mistakes or failures more costly. Thus systems must be designed more carefully and monitored more stringently. Substantial monitoring processes currently exist, but further development is necessary in many cities and countries to both maximize the benefits and minimize the costs.

Notes

1. U.S. Department of Agriculture, Foreign Agriculture Service (USDA/FAS). 2000. *A Millennium Free from Hunger*. Washington, D.C.: USDA/FAS, p. 13.

2. Marie T. Ruel, James L. Garrett, Saul S. Morris, Daniel Maxwell et al. 1998. *Urban Challenges to Food and Nutrition Security: A Review of Food Security, Health, and Caregiving in the Cities*. Paper No. 51. Washington, D.C.: International Food Policy Research Institute.

3. Urban diets are on average more diverse than rural diets because a larger variety of food is available, and in general urban diets are better in both energy and micronutrient content.

4. Ruel et al., 1998, op. cit.

5. Barry M. Popkin and Eilene Z. Bisgrove. 1988. Urbanization and Nutrition in Low-Income Countries. *Food and Nutrition Bulletin* 10(1).

6. Diana Lee-Smith et al. 1987. *Urban Food Production and the Cooking Fuel Situation in Urban Kenya: National Report — Results of a 1985 National Survey*. Nairobi: Mazingira Institute.

7. Camillus J. Sawio. 1993. Feeding the Urban Masses: Towards an Understanding of the Dynamics of Urban Agriculture and Land-Use Change in Dar es Salaam, Tanzania, PhD diss. Worcester, Massachusetts: Clark University.

8. **[first name]** Evers (1983), quoted in David Drakakis-Smith. 1992. And the Cupboard was Bare: Food Security and Food Policy for the Urban Poor. *Geographical Journal of Zimbabwe* 23.

9. Pascale Dennery. 1995. Inside Urban Agriculture: An Exploration of Food Producer Decision Making in a Nairobi Slum, Master's thesis. Wageningen, Netherlands: Wageningen University, Department of Ecological Agriculture.

10. Alice Mboganie Mwangi. 1995. *The Role of Urban Agriculture for Food Security in Low Income Areas in Nairobi*, Report No. 54. Nairobi: University of Nairobi, Food and Nutrition Studies Program.

11. Andy Fisher. 1999. Happy Fifth Birthday! *Community Food Security News*, Summer: 1 and 5.

12. While the concept as used today originated in the USA, variants can also be found in other countries.

13. These examples were reported in various issues of *Community Food Security News*, 1996-1999; and Christopher D. Cook and John Rodgers. 1996. Community Food Security: A Growing Movement, *Food First Backgrounder*, Spring.

14. Gleaning consists of recovering usable produce, bread, fish, and other edibles from fields, bakeries, and food stores for distribution to the disadvantaged.

15. R. Martin and T. Marsden. 1999. Food for Urban Spaces. *International Planning Studies*. 4(3):407.

16. Several that were studied are described in Mwangi, 1995, op. cit.

17. For a thorough review of the links between health and environment, see David Satterthwaite. 1993. The Impact on Health of Urban Environments. *Environment and Urbanization* 5(2):87-111.

18. In addition to the availability and safety of the food supply, food quality, and access to it, , nutritional security of a child depends on such factors as the quality of parental caregiving, availability of medical services, and sanitation of the living environment.

19. Daniel G. Maxwell. 1993. The Impact of Urban Farming in Kampala on Household Food Security and Nutritional Status, paper presented at the first Crop Science Conference for Eastern and Southern Africa, Symposium on Women and Agriculture, Kampala, Uganda. 14-18 June.

20. Mwangi, 1995, op. cit.

21. Daniela Soleri, David Cleveland, and Timothy Frankenberger. 1991. Gardens and Vitamin A: A Review of Recent Literature, Report No. IN-2, prepared for the U.S. Agency for International Development, Office of Nutrition by the University of Arizona. Arlington, Va.: Vitamin A Field Support Project.

22. Robin Marsh. 1994. Nutritional Benefits from Home Gardening. *ILEIA Newsletter* 10(4), Dec.

23. **[first name]** Schoefield (1991), quoted in Paul Sommers. 1994. Promoting Urban Agriculture: A Strategy Framework for Planners in North America, Europe and Asia. *In* Urban Agriculture and City Planning in North and South. An IDRC Panel, Habitat 94 conference papers. Edmonton, Alberta, Canada: International Development Research Centre.

24. AVRDC. 1991. *Annual Report.* Kaohsiung, Taiwan: Asian Vegetable Research and Development Center.

25. International Institute for Rural Reconstruction. 1990. *Annual Report: Family Food Production Program for Negros.* Silang, Cavite, Philippines: IIRR/UNICEF.

26. Florentino Solon et al. 1979. An Evaluation of Strategies to Control Vitamin A Deficiency in the Philippines. *American Journal of Clinical Nutrition* 32:1445-53, quoted in Daniela Soleri et al., 1991, op. cit

27. Kinshasa — The Garden Spot of Africa. 1992. Telegram from the U.S. Embassy, Kinshasa, Zaire to the Secretary of State, Washington, D.C., 10 Apr.

28. A change in mandate for Peru Mujer resulted in a shift of its activities away from Lima in the mid-1990s. Andres Dasso, REDE, Lima, personal communication, 2000.

29. Some recent studies confirm the important economic contributions of urban agriculture. See, for example, the studies by Mvena et al.; Lee-Smith et al.; Schilter Gutman et al.; and Yeung listed in Appendix G.

30. Irene Tinker. 1993. Introductory comments, Canadian African Studies Association Conference, Toronto, May 1993.

31. Lee-Smith et al. 1993. *Urban Food Production*; and Daniel G. Maxwell, *Land Access and Household Logic: Urban Farming in Kampala.* Kampala, Uganda: Makerere Institute of Social Research.

32. Sustainable Cities Programme. 1992. *Dar es Salaam: Environmental Profile.* Nairobi: United Nations Centre for Human Settlements, p. 8.

33. Bishwapriya Sanyal. 1985. Urban Agriculture: Who Cultivates and Why. A Case Study of Lusaka, Zambia. *Food and Nutrition Bulletin* 7(3):15-24, Sep.

34. R.E. Heimlich (ed.). 1989. *Land-Use Transitions in Urbanizing Areas.* Washington, D.C.: The Farmland Foundation and USDA; see especially pp. 207-17.

35. Yue-man Yeung. 1985. *Urban Agriculture in Asia.* Paris: United Nations University, Food-Energy Nexus Programme.

36. Allison Brown, personal communication, 1993.

37. A.E. Boakeye. 1982. Agricultural Development on Urban Fringes, unpublished.

38. Julie A. van der Bliek. 1992. *Urban Agriculture: Possibilities for Ecological Agriculture in Urban Environments as a Strategy for Sustainable Cities.* Leusden, Netherlands: ETC Foundation, Consultants for Development Programmes.

39. Fifty jobs per hectare were documented from hydroponics in Bogotá, and 40 jobs per hectare for raised-bed salad production in San Francisco. Jorge Zapp, personal communication, 1993; *Natural Life* (July/Aug 1992).

40. Emilio L. La Rovere. 1985. *Food and Energy in Rio de Janeiro: Provisioning the Poor*. Tokyo: United Nations University, Food-Energy Nexus Programme.

41. Herbert Girardet. 1999. *Creating Sustainable Cities.* Green Books, p. 13.

42. These are elaborated in Jane Carter. 1995. *The Potential of Urban Forestry in Developing Countries: A Concept Paper*. Rome: Food and Agriculture Organization; Guido Kuchelmeister. 1991. *Urban and Peri-Urban Multipurpose Forestry in Development Cooperation*. Illertissen, Germany: Commission of the European Communities; and Mark Sorensen. 1997. *Good Practices for Urban Greening.* Washington, D.C.: Inter-American Development Bank, Social Programs and Sustainable Development Department, Environment Division.

43. UNESCO, FAO et al. 2001. Biological Diversity and the Urban Environment. *Issue Paper No. 1,* Ecosystem Conservation Group. Nairobi: UNEP.

44. Jane Carter, 1995, op. cit.

45. Ibid.

46. E.G. McPherson et al. (eds). 1994. Chicago's Urban Forest Ecosystem: Results from the Chicago Urban Forest Climate Project, General Technical Report NE-186. Radnor, Pennsylvania.: U.S. Department of Agriculture, Forest Service.

47. G. Moll and C. Kollin. 1997. A Case Study: Urban Environmental Analysis in Atlanta, USA. *BUFPRA Newsletter,* Nos. 1-3.

48. World Bank. 1989. *Sub-Saharan Africa: From Crisis to Sustainable Growth* Washington, D.C.: World Bank.

49. E.H. Sene. 1993. Urban and Peri-Urban Forests in Sub-Saharan Africa: The Sahel. *Unasylva* 44(2):45-51.

50. M. Birley and K. Lock. 1999. *A Review of the Health Impacts of Peri-Urban Natural Resource Development.* Liverpool: Liverpool School of Medicine.

51. Darmajanti. Integrating Informal City Farming. **[Need date and publisher]**

52. Jane Carter, 1995, op. cit. Note that particulates were lower by 2000 as a result of various measures.

53. Guido Kuchelmeister. 1997. Urban Trees in Arid Landscapes: Multipurpose Urban Forestry for Local Needs in Developing Countries. *Arid Lands Newsletter* No. 42, Fall/Winter.

54. McPherson et al., 1994, op. cit.

55. Carl Bartone et al. 1994. *Toward Environmental Strategies for Cities: Policy Considerations for Urban Environmental Management in Developing Countries*, Urban Management Program Policy Paper 18. Washington, D.C.: World Bank.

56. The vulnerability of unplanted urban slopes to landslides became painfully evident after the disastrous rainfall on the northern coast of Venezuela in 2000.

57. Guido Kuchelmeister, 1997, op. cit.

58. See Case 6.3 for sources.

59. Jane Carter, 1995, op. cit.

60. Peter Henderson. 1991. *Gardening For Profit.* Chillicothe, Illinois: The American Botanist, Chapter VI.

61. Figures from the periodical *Waste Management,* Oct 2000.

62. M.B. Pescod. 1992. *Wastewater Treatment and Use in Agriculture*, Report 47. Rome: Food and Agriculture Organization.

63. See, for example, Case 5.4 on duckweed and Case 5.5 on aquaculture.

64. For overviews of ecological sanitation, see Uno Winblad. 1997. Ecological Sanitation, A Global View. *Ecological Alternatives in Sanitation, Proceedings of a Workshop.* Stockholm: Swedish International Development Agency; and Steve Esrey et al. 1998. *Ecological Sanitation.* Stockholm: Swedish International Development Agency, Chap. 3.

65. Harvard Institute for International Development. 1992. *Enterprises for the Recycling and Composting of Municipal Solid Waste in Jakarta, Indonesia.* Jakarta: Center for Policy and Implementation Studies.

66. The Dakar research is supported by IDRC's Cities Feeding People program.

67. Anuradha Mittal. 1999. Small Farms. *Food First* 6(4).

68. See www.iwmi.org.

69. Julio Henao and Carlos Baanante. 1999. Nutrient Depletion in the Agricultural Soils of Africa. *2020 Vision Brief 62.* Washington, D.C.: International Food Policy Research Institute, Oct.

70. Ignacy Sachs and Dana Silk. 1990. *Food and Energy: Strategies for Sustainable Development*. Tokyo: United Nations University Press. Chapter 5 summarizes the benefits and problems of urban agriculture.

71. World Sustainable Agriculture Association, newsletter, Fall 1993.

72. Kornelis Smit, chief engineer, R.S. Means Co., Plymouth, Mass., personal communication, 1993.

73. E. Darmajanti. 1994. Integrating Informal City Farming Practices into Green Space Management, Master's thesis. Toronto: York University, Faculty of Environmental Studies.

74. Walther Manshard. 1992. Agricultural Change: Market Gardens in West African Urban Communities — The Case of Ouagadougou (Burkina Faso). In *Development and Ecology: Essays in Honour of Professor Mohammad Shafi* (Mehdi Raza, ed.). Jaipur and New Delhi: Rawat Publications.

75. U.S. Embassy, Kinshasa, Zaire, 1992, op. cit.

76. UNICEF and Kampala City Council. 1981. Nutritional Status of Young Children in the Poorer Parts of Kampala.

77. Maxwell, 1993, op. cit.

78. E. Echeverria, World Bank, Washington, D.C., personal communication, 1991.

79. ????

80. Data concerning the nutrition and health benefits of food-based interventions await study by a future researcher. Some of these data can be found in the files of the operating relief agencies. Africare and UNICEF have data on interventions in Africa. Save the Children America has data on the interventions in Honduras during the civil war in Nicaragua.

81. Institute for Food Development and Policy. 1999. *The Years of Crisis.* San Francisco: Institute for Food and Development Policy (Food First), May .

82. Eugenio Fuster. 1999. Deputy Minister Agriculture, Presentation at Growing Cities, Growing Food conference in Havana, Cuba, Oct.