Food Production in Cities

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Abstract
Urban food production through urban agriculture is becoming part of urban development for a variety of reasons. There is increased production in periurban areas of cities in the developing countries. Many large cities took up the policy to produce food within the cities. Recycling of waste water for aquaculture is being practised. There are potentials on rooftops, home gardens etc. In the future, urban agri-horti-aquaculture could be incorporated in design of the cities for ecological, aesthetics, functional, economic and environmental benefits.

INTRODUCTION
The 21st Century will be an urban century. As the cities become larger environmental problems increase also. The urban sprawl has destroyed agricultural land, forest cover and filled up the water bodies in the periphery of cities while at the centre historic quarters are demolished in favour of highrise buildings and high density housing creating problems of traffic, water, drainage etc. The conventional industry, due to change in technology, has declined and agricultural productivity has become stagnant in many countries due to climate change, soil erosion, use of chemical fertiliser etc. Food security to cities and urban communities has become critical also.

The garden of Eden, garden of Babylon and gardens in ancient and medieval cities were full of fruit trees, vegetable farms and water bodies with fishes. In many pre-industrial towns agriculture was dominant and even in the beginning of the 20th century garden city movement was propagated.

Urban food production system is now being accepted in town-planning, and urban agriculture is a broader subject. It includes aquaculture (aquatic plants and pisciculture), horticulture (household, kitchen, community and market gardening, roadside, rights of way, and stream side horticulture, soil less and vertical horticulture), special crops animals (poultry, cattle and other livestock), agroforestry, and production of multipurpose wood and others (snail-raising, ornamental fish, silk worms, medicinal herbs etc.) (Mougeot 1994) (Table 1). Urban agriculture has returned to cities to improve food security, nutrition supply, employment, environment and to enhance ecological sustainability. It utilises solid and liquid waste to a great extent and contributes to land greenergy, and waste management in the cities (Smit 1996).

URBAN FARMING
The cities receive much raw materials, water and other resources and produce waste. The cities are not a part of ecological system, and conventional town planning or land use planning do not deal with environmental sustainability.

McHarg (1969) who took naturalist view of urban and regional planning suggested about thirty ecological factors under broad categories of climate, geology, physiography, hydrology, pedology, vegetation, wild life and landuse. Mollison (1988) developed permaculture in Australia. Permaculture (permanent agriculture) is the conscious design and maintenance of agriculture productive ecosystem which have the diversity, stability and resilience of natural eco-systems. This establishes harmonious relationship of landscape and people working with nature (Mollison 1988).
Urban agriculture contributes to urban ecosystem by reusing its waste to produce food and fuel which reduces both the intake and the output in the resource stream. Urban agriculture has become a powerful element for sustainable cities using waste water, derelict land, vacant space and water bodies as potential resource areas.

Smit (1995) lists benefits of urban agriculture in land and waste and disaster management, reduced traffic infrastructure and reduced cost of food subsidy. He estimates that above 800 million people throughout the world are engaged in urban food production. A metropolitan area which is in the urbanization process has much rural areas, non municipal low density urban areas and pockets of unused open space, derelict land, abandoned railway or industrial lands and water bodies. At first in the periurban areas urban agriculture can work as green buffer between the urban and rural areas.

In Vietnamese cities, a total of 26 varieties of vegetables are produced around the cities. Most species yield between 10 t/ha and 30 t/ha and leafy vegetables are produced near the markets. Organic materials used are animal dung, compost, coconut or rubber cellulose and wood dust. Sometimes chemical fertilizer and pesticides are applied (Jansen et al. 1994).

Due to sanction and scarcity of food, Cuba officially adopted urban food production in 1999. Havana has about 26000 self provision gardens, half of them close to homes, with plot sizes varying from 18-40,000 m². Community gardens produce fruits and vegetables and no fertilizer is used. Havana is a low density city and master plan includes urban agriculture areas (Moskow 1999).

Turner (1995) states that home gardeners are most productive of all food producers. He stated that 232 m² is sufficient to produce enough food for one person. Many cities contain vast tracts of potentially productive derelict land. In USA there are 86 cities that produce food and on average there is 212 m² of vacant land per person. 40,000 ha of such land is estimated to be in London and over 70,000 ha in New York. In New York there are 1100 city farms of different types (Turner 1995).

The UNDP report on Urban Agriculture (Smit 1996) states: “Throughout Europe there is a new interest in community garden or allotments. There are 80,000 community gardens on municipal land in Berlin with a waiting list of 16000.” It refers to the Dutch cities and agriculture within cities. This “green core features high value crops, plastic shelters to stretch the season, marketing cooperatives, extension services, research centres, credit facilities, farm environmental controls and training”.

In Canada there is growing vision of community food security involving community and allotment gardening, rooftop and back-yards gardens and urban farms. Out of total 100 community gardens in Montreal 73 are maintained by the City which provides the land, equipment and materials, as also offers water, garbage collection, and the services of horticultural animators (Fairholm 1999).

In U.K. city farm movement has grown up from the initial start in 1970. There are about 2.5 million visits to city farms annually. There is National Federation of City Farms in Bristol, Besides urban food production, city farms have educational, ecological and other roles (Sharps 1995). Greater London has 6783 ha of urban agriculture land, 8000 ha of other greenbelt land, 831 allotment gardens and 13 ha city farms etc. total 21706 ha which is 20% of total area available for vegetable and fruit production. There are about 1000 beekeepers and London produces 2700 kg honey annually (Garnett 2000).

Many cities have flat roof buildings, mostly unused. Barrs (1997) writes, “In Europe where sprawl is no longer possible, city planners have adopted rooftop greening out of necessity. Some German municipalities have decreed by law that new industrial buildings must have green roof. Swiss cities regulate the new construction, with regulations i.e. it must recreate the displaced green space, even existing buildings must convert 20 % of their roof space into greenery “.

In Mexico city in the central urban zone, vegetable and fruit production are limited and surprisingly livestock development especially backyard pig rearing is quite common. Chinampa system is fine example in suburban area. It is a traditional concept—a farm of intensive agriculture that use silt, human excreta etc. The vegetation and animal
production system are integrated. Legumes, flowers and ornamental plants are produced. In the periurban area including upland area there is production of nopal cactus, maize, dairy, livestock etc. (Losada et al. 1999).

In African cities, urban agriculture is practiced by poor and low income people but in conventional town and landuse planning this is considered illegal and often crops and vegetables are destroyed. Maize slashing by the city authority is quite common. In Harare, maize, vegetables and flowers are grown and many people keep livestock, especially in the periphery of the city. Maize is taken to hammer mills and the number of such mills are in the increase on the neighbourhood. In Kenyan towns it is reported that twenty nine percent of urban households grow crops in towns. Informal urban-agriculture contributes significantly to the urban economy (Mbiba 1995). Faced with food shortages, urban food production is being accepted officially as one of the basic urban functions. In Dar es Salam, Tanzania about 100,000 tons of food are produced besides livestock, Urban agriculture is the second employer, employing more than 20% of all employed (Ratta & Nasr 1996). Many of the African countries are importing food and there is increasing food insecurity in urban areas. There is need for food production, supply and distribution system. Most of the fruits and vegetables are perishable or semi-perishable and require storage and wholesale markets. UN Food and Agricultural Organisation has emphasized these, Cassava tuber trade is dominant in Kinshasa, Zaire which is done in 55 open spaces and 100 retail markets but there is no wholesale market. In Nairobi, Kenya, however, there are many wholesale markets and new ones have been constructed. In the mediterranean region markets are there but with growing population, they are inadequate in cities, and location, distribution and regulation etc. are of concern (Tollens 2000).

A report on periurban vegetable production in Ho Chi Minh city, Vietnam (Jansen et al.1994) states that returns per labour per day per hectare of vegetables are double or more than those for rice, providing employment for five or more times than for rice. Besides irrigation, organic materials, chemical fertiliser, pesticides, market oriented production was suggested.

In Jakarta, Indonesia more than 11000 ha of land are used for urban agriculture. The land includes vacant land, riversides and roadsides, home gardens and others. Purnomohadi (2000) suggests inclusion of urban agriculture in city planning zoning. Local government should deal with production, marketing and consumer aspects with new facilities, regulations etc.

Out of 8.5 million people working in Shanghai about 3.6 million are in the agriculture production sector. It is a policy to make Shanghai self-sufficient in some cereals and to produce about 2 million tons of grain per year. Vegetable production covers more than 10,000 ha. The number of green houses is increasing. There is new technology for 287 horticultural farms. A 700 ha greenbelt has been established where vegetables are produced. Livestock has developed, 100% of milk and 90% of eggs consumed in Shanghai is produced within city-limits (Yi-Zhang & Zhangen 2000).

In northern Philippines sweet potato based gardening, a traditional cultural practice, was taken a long term programme in cities. As for example in Baguio city, under Philippines Plan of Action for Nutrition (PPAN) 27000 school kitchen gardens, 42000 community kitchen gardens, 1600,000 home kitchen gardens were planned and about 1505 small animals were disposed during 1994 – 98 (Gayan 1996).

**AQUACULTURE**

The World Health Organisation in 1989 suggested reuse of waste water for aquaculture and agriculture rather than expensive waste water treatment method (Edwards 1992). There are indigenous and conventional method in the reuse of wastewater. Sewage and waste water fed fisheries in many Asian and some Latin American cities are producing fish. Calcutta in India has the largest recycling district in the world with about 12000 ha in east Calcutta. In 1959-60 the total area of wetland area was more than 10,000 ha but due to large scale conversion into paddy cultivation, vegetable fields and urban development (including construction of a new town) the total area is now about 2500 ha.
which is also threatened and now the fish ponds are only 140 in numbers. The indigenous or conventional method is used widely. The Calcutta Municipal system generates about 750 million litres of wastewater daily. The waste water is taken into lagoon type pond with depth up to 1.5 m to facilitate natural aeration and to allow sunlight to reach its bottom to promote algae growth and photosynthetic oxygen production. The phytoplankton and microorganisms are responsible for fish food chain. Water hyacinth (Eichhornia crassipes) or duckweed (Lemna sp., Spirodella sp.) are used to purify water also by absorption of particles on the roots and oxygen production. The fish production is 5-7 tons/ha annually and it provides employment besides food (Jana 1998).

In South east Calcutta a Fishermen’s Cooperative Society in Mudialy has taken lease of land with 15 ponds, about 50 ha in area, from the Calcutta Port Trust and waste and sewage water from adjoining industrial area is treated and fishery has been developed and the area has been transformed into an ecology park. Three projects in rural fringe of metropolitan area have been taken up with the participation of local people, fishermen and village council. The Community Based Wetland Ecosystem (CBWE) has been first introduced in 1995 in Titagarh, a northern industrial town in Calcutta Metropolitan Area (Ghosh 2001).

In China Filter (Filtration and Irrigated cropping for land Treatment and Effluent Reuse) technique has been used which can reduce pollutants level in drainage water while maintaining hydraulic flow, crop yields and nutrient removal potentially to make it a sustainable system (Xianjun 2001). In 1985 China produced 30,000 tons of waste water fish and it is reported that most municipal waste water in Chinese cities is drained into various water bodies that are used as fish ponds (Zhang 1990).

In Hanoi, the most important feature of sewage is that it contains both untreated domestic (70%) and industrial waste water (30%). The waste water is being used for fish farming, irrigation of vegetable and paddy fields, in Thanh Tri district. It produces about 3000 tons of fish and nearly 20000 tons of vegetables annually. (Thang et al. 1995).

There are more examples from other cities from other countries in Asia-Bangladesh, Taiwan, Thailand, and Cambodia where recycling of waste and production of food is gaining momentum. Further research and development are required with respect to health hazard on the reuse of waste water. The WHO has provided some guidelines (WHO, 1994).

OTHER INNOVATIONS

Today cities have become congested and vacant open space is being constantly encroached upon and water bodies are being filled up. New and innovative techniques are being adopted. There are various natural composting techniques. R.T.Doshy, an economist has developed the compost which is based on 95% solar energy and 5% soil. He is getting 5 kg of vegetables daily from 100 m² roof space in crowded Mumbai, India.

In Bogota, Columbia with UNDP supports poor people to learn to grow vegetables on rooftop with organised marketing system (Kundall 1995). Hydroponics and soilless horticulture are quite developed in the Netherlands and Israel.

In Auroville, a new town in South India wasteland reclamation through rehabilitation of eroded soil is being done by planting selective plant species. In the tropical garden fruit trees have grown on concrete with little soil. Trees planted are of different heights. According to Barnerd and Deepika, creators of this garden, “The Amazon rain forest grew on poor soil. And variety of fruit trees and vegetables and flowers can grow on 12 layers of composted leaves. The leaves are soaked in water overnight. Some wood ash and earth worms are added in composting process (Auroville Today 2001).

Kajima Corporation and Geostr. Corporation of Japan invented wet concrete which sucks water. It is composed of cement, sand, rock, water and plant fibre and epoxy resin covered steel. The plant fibre maintains water content 20 to 40% and it is light by 30% and any plant can grow over it. (BE, 2001). In the middle east and in unfavourable climate area green house technology has been adopted especially for floriculture. A
Swedish horticulturist in Botswana has developed container gardening in boundary wall which produce good quantity of tomato.

**THE GREENING OF CITIES**

If urban food production is to increase, urban agriculture including urban horticulture and aquaculture is to be improved access and right to land development and infrastructure, control of water and environment, provision of credit and marketing facilities etc. (Richter et al. 1995). There is a Persian proverb, “It is forbidden to live in a town which has no garden or greenery” (Roberts and Amidon 1991). Trees, open spaces, gardens etc. are essential parts of town design. To control urban sprawl, green belts were suggested around metropolitan cities, like London. In 2000, Washington D.C. plans wedges of green separated urban corridors. New techniques of urban design include the open space techniques, the transportation system, the capital network technique, physical design etc. (Spreiregen 1965). There are several urban design concepts for future cities where urban agri horti-aquaculture can be incorporated for aesthetic, functional, ecology-environmental reasons as well as for food production. A greening with food production plan for a city may include a green belt around cities where agro and aquafarms, forestry and livestock and poultry are developed, wedges of greenery and urban forests and parks – developing a network of greens including waterbodies and recreational areas, avenues of trees with street design and landscaped areas, periurban areas, derelict, abandoned and vacant areas where utilisation of organic waste can lead to greening and fishery and livestock and poultry development, spot locations for edible landscape in industrial, governmental, institutional areas, and housing estates and private and community gardens including home gardens.

However, all these must be integrated into an ecological plan with urban agriculture which is an example in the best practice for the sustainable development of cities.

**Literature Cited**


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Table 1. Farming systems common to urban areas.

<table>
<thead>
<tr>
<th>Farming System</th>
<th>Product</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture</td>
<td>Fish and seafood, water vegetables, seaweed and fodder.</td>
<td>Ponds, lakes, rivers, canals, estuaries, sewage lagoons, drainage basins with water, reservoirs and wetlands.</td>
</tr>
<tr>
<td>Horticulture</td>
<td>Vegetables including mushrooms, fruit, cereals ornamental plants, compost.</td>
<td>Homegardens, parks, open space, derelict land, abandoned yards, institutional areas, roof tops, roadside, container gardening, greenhouses suburban farms, soilless culture, hydroponics etc.</td>
</tr>
<tr>
<td>Agro-forestry</td>
<td>Fuel, wood, fruits and nuts, building material, compost.</td>
<td>Orchards, forest parks, green belts.</td>
</tr>
<tr>
<td>Livestock</td>
<td>Meat, milk, eggs, manure, hides and skins.</td>
<td>Open space, grazing area, periurban area, roadside trees, homegardens, slope and hill sides, pens and sheds, animal farms.</td>
</tr>
<tr>
<td>Others</td>
<td>Medicinal and house plants, herbs, beverages, flowers, honey, insecticides.</td>
<td>Green houses, Roof tops, beehives, cages, urban forests containers.</td>
</tr>
</tbody>
</table>

Source: The Urban Agricultural Network, Washington D.C., USA and Centre for Built Environment, Calcutta, India, 1996.