

ROOFTOP AGRICULTURE FOR A SUSTAINABLE FUTURE OF URBAN AREAS

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Abstract

Rooftop farming is becoming increasingly popular all over the world. It can provide urban dwellers with access to fresh produce that they grow by themselves, in their particular locality. Areas for growing food are usually scarce or completely missing in cities. However, the rooftops of buildings are usually unused and thus, they could make up for the lack of space on the ground. Growing food on rooftops can bring daily pleasure to the urban dwellers, contribute to improving their health and make their lives more pleasant. Rooftop farming is also important for strengthening of social relations in communities.

Keywords

Urban agriculture, sustainability, residential rooftop farms, building-integrated agriculture, controlled-environment agriculture, soilless farming

1 INTRODUCTION AND BACKGROUND

People in developed countries do not often perceive the growing risk of food shortages because food is still available in these countries, despite some losses during its production, sale and distribution. Food shortages are frequently regarded as a problem that primarily affects developing countries.

However, the global population is steadily increasing, and scientists predict that by 2050, most of the people will live in cities. Even now, food often needs to be imported to cities from afar. This is typically due to the decline in local food production which is caused by deteriorating conditions for farmers. All of this results in higher CO₂ production and increases the carbon footprint. [1].

Apart from transport, the use of fertilisers to grow and store food (maintaining constant temperature, refrigeration, packaging, etc.) in large-scale production also worsens the carbon footprint. This is reflected in the reduction in the content of vitamins and substances which are essential for human health and, above all, in the deterioration of the taste of imported fruit and vegetables [2].

It is therefore necessary to continuously seek more sustainable alternatives to move part of the food production into cities. Urban agriculture can be applied in a various form, for example on undeveloped plots of land, on the facades and rooftops of buildings or indoors (Fig. 1) [3].



Fig. 1 Basic forms of urban agriculture [author's archive].

2 ROOFTOP FARMING AS A FORM OF URBAN AGRICULTURE

One of the forms of urban agriculture is rooftop farming (also referred to as **Zero-Acreage Farming** in literature) [4]. Rooftop farming can be practised both on the outside of buildings and indoors. Indoor farming has the advantage of the year-round production, higher yields and more efficient water management. In times of food crisis, it can make up for shortages of certain agricultural crops. There are two types of urban agriculture: urban farming, which is aimed at commercial use, and urban gardening, which is intended for non-commercial purposes, such as growing fresh food for self-consumption and relaxation of the urban dwellers, as well as for social purposes (schools, hospitals, etc.) (Fig. 2) [5].

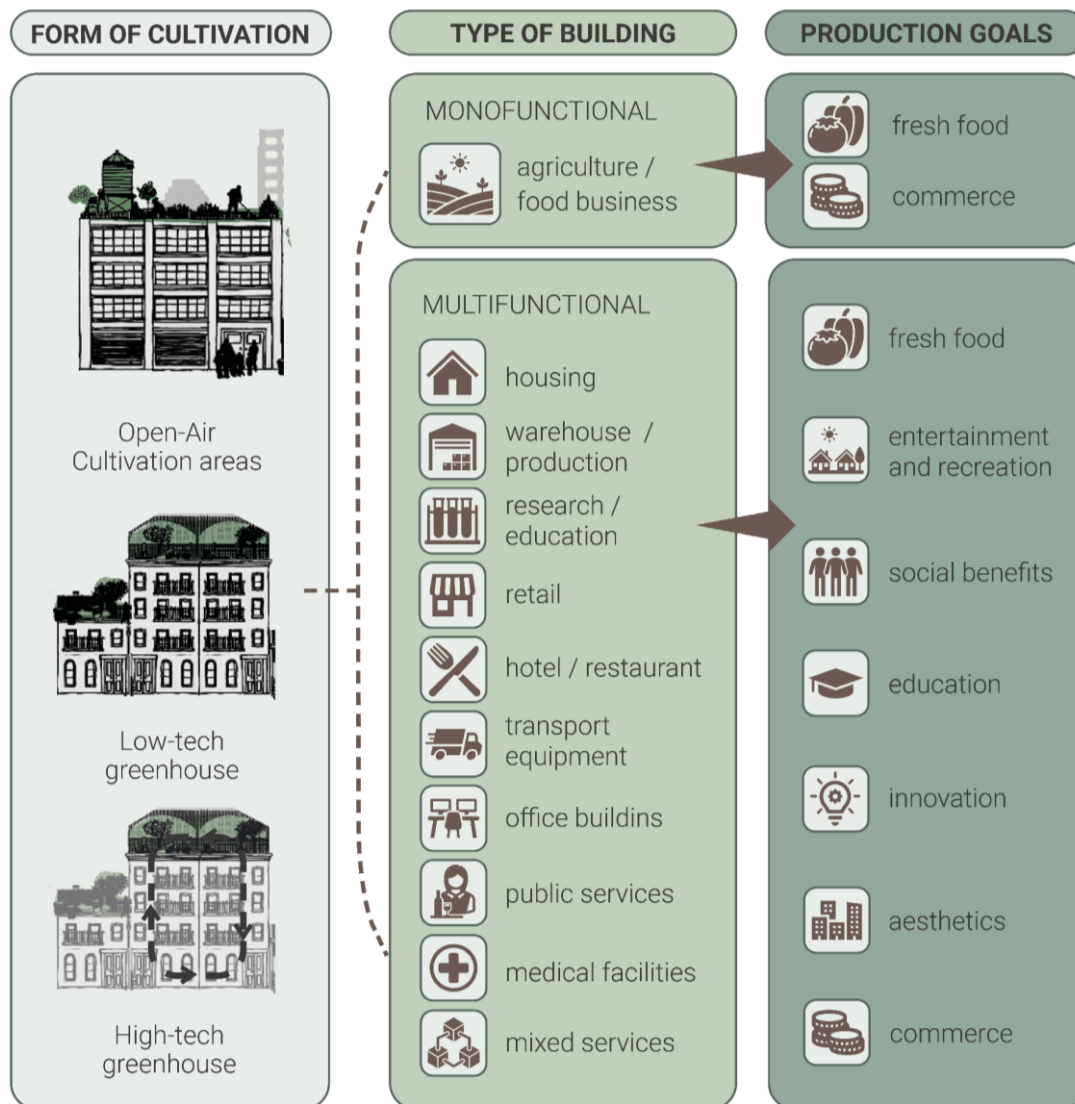


Fig. 2 Opportunities for rooftop farming [5].

Under certain conditions, agriculture on the outside of a building can help to improve the energy performance of the building, especially in summer, and can make a positive contribution to reducing air conditioning costs, particularly in renovated buildings. The system can be applied to the building's envelope or roof, or it can be put inside the building [6].

2.1. Open-Air Cultivation Areas

Open growing areas on buildings include intensive and semi-intensive vegetated roofs, raised beds and container gardens. Crop cultivation takes place in the open air in an unprotected environment.

Intensive and semi-intensive vegetated roofs with edible plants - the design of these vegetated roofs is limited by the load-bearing capacity of the buildings. The thickness of the substrate usually ranges from 25 cm to 120 cm (saturated weight 350–1500 kg/m²) [7]. They are relatively low-tech, but they require more demanding maintenance, fertilization, regular watering of plants and possibly an irrigation system or weatherproofing of crops (pergola, shading, support for taller plants, etc.) (Fig. 3) [8], (Fig. 4) [9].



Fig. 3 Garden Village Apartments in Berkeley [8].



Fig. 4 The Chicago Botanic Garden [9].

Raised beds - The ideal height of the beds is 45–80 cm. The construction of the bed can be designed in wood, concrete, plastic or metal and can be supplemented with an irrigation system (Fig. 6). The beds are suitable for growing vegetables with deeper root systems, such as root vegetables, tomatoes or peppers. They can also be used for growing herbs (Fig.5) [10].



Fig. 5 Community Garden at the DADA district apartment building [author's archive].

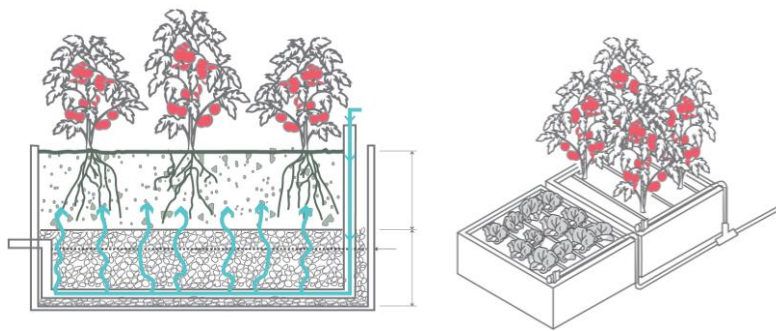


Fig. 6 Example of a raised bed irrigation system [author's archive].

Container gardens are less stable than raised beds. Mobile planters, pots etc. are used (Fig. 7) [11]. They allow flexibility which means that containers can be moved as required. Container gardens are suitable for lower weight roofs. Suitable crops for growing in containers include herbs, leafy vegetables, strawberries, bush tomatoes, etc. Irrigation can be carried out by drip irrigation or by using self-watering containers [12].



Fig. 7 Rooftop container garden [11].

2.2. Low-tech greenhouses

These are simple lightweight structures (polytunnels or polycarbonate and glass greenhouses) made of aluminium, wood or plastic (Fig. 8) [13]. Their light weight makes them suitable for buildings with a lower load-bearing capacity. They provide plants with protection from sunlight, weather and partially low temperatures - they can extend the growing season of the crops grown. They are simple and low maintenance, and they make use of natural ventilation. [10].



Fig. 8 Rooftop gardens of the ØsterGro project in Copenhagen [13].

2.3. High-tech greenhouses

High-tech greenhouses represent the growing of crops in a controlled, enclosed environment (Controlled Environment Agriculture - CEA). These types of greenhouses can use hydroponics, aquaponics or aeroponics (Fig.9).

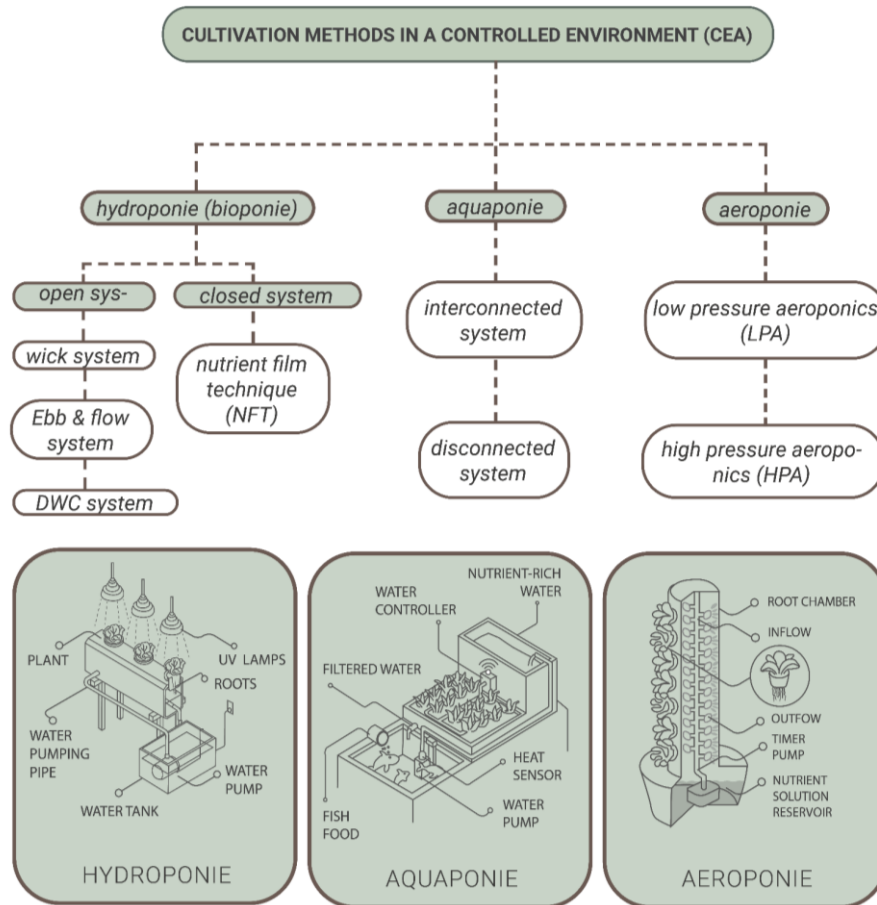


Fig. 9 CEA classification [author's archive].

The aim is to provide food with protection against the risks of growing outdoors, such as drought or frost, pest infestation, etc. It is not necessary to rely on ideal weather or a suitable growing location. Fruit and vegetable production is possible all year round. In addition to food crops, crops can also be grown for pharmaceutical purposes or for biofuel production. Greenhouses can be located both on rooftops and inside renovated buildings [14], (Fig. 10) [15], (Fig. 11) [16].



Fig. 10 Hydroponic farm at Arbor House, Bronx NY [15].



Fig. 11 Hydroponic farm at the Arbor House building, Bronx NY [16].

3 DISCUSSION

Rooftop farming is gaining popularity around the world; due to the many benefits it provides. The largest number of implementations can be found in North America and Europe. Rooftop cultivation has a lot of potential for the future. It could improve the quality of life in cities, which are becoming overcrowded, and contribute to urban food self-sufficiency.

Many urban dwellers long to have their own allotment on the ground but these areas are mostly lacking in cities. The people address the lack of allotments in various ways, for example by growing vegetables in pots, on their balconies, etc. Rooftop farming could be a more effective solution to this problem. However, the current legislation does not sufficiently address this issue in our conditions yet, focusing mainly on extensive vegetated roofs without irrigation. In the future, it would be good to address the issue of rooftop farming in our country in more detail and to include it in the legislation.

4 CONCLUSION

The main significance of community gardens and rooftop gardens lies in the fact that they can compensate for the lack of growing areas on the ground. These are in short supply in crowded cities. Rooftop areas offer a unique opportunity to grow fresh vegetables and fruit right there where you live. Gardens can also compensate for the lack of contact with nature and provide urban dwellers with relaxation zones and various educational opportunities.

Commercial farms (both protected and unprotected) can provide a large amount of fresh produce to urban dwellers, as the experience from many projects around the world shows. These implemented farms can provide healthy food not only to local retailers, but they can also supply fresh produce to local schools, health facilities, restaurants, etc. Rooftop agriculture can thus be regarded as one of the ways to cope with the food crisis caused by urban population growth and global climate change. Integrating food production into urban areas have the potential to provide local people with employment, improve their access to nutritious food and enable them to lead healthier lifestyles.

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