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the alliance for
better food and farming

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Edible Buildings
-benefits, challenges and limitations

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Not a new concept

In many parts of the world growing food on and around buildings is an economic necessity. Herbs are grown on rooftops in Santiago, silkworms on balconies in Old Delhi, pigeons in downtown Cairo, rabbits in Mexico City shanties and vegetables in Haiti[1]. Some city farmers attach containers to their walls and grow melon and cucumber up them, whilst others keep goats and cows on rooftops.

Sustainable *strategies* of particular relevance and significance to 'edible' architecture [agritecture] include the maximum use of; vertical height, micro-climates and reflected light, and water; conservation, de-contamination, and recycling, and the production of high yielding, high turnover and high value crops.[2] Commercial enterprises are likely to concentrate on a small number of crops whilst amateur gardeners a greater diversity. Garden design strategies may follow permaculture and ecological principles to maximise yields whilst benefiting people and the environment.

Sustainable *techniques* of importance in an urban context include organic; cultivation, composting and biological pest control, spatial and temporal annidation[3], intercropping, companion planting, and 'guilds'.

Appropriate food crops will depend on a large number of factors ranging from the macro and microclimates to the time and income of participants. Potentially suitable species for using in conjunction with walls and other structures in temperate climates include; cherries, kiwi, apples, pears, peaches, hops, courgettes and squash, peas and beans, blackberry, loganberry, red, black, and white currant, gooseberries and figs. Plants will benefit from the stabilisation of temperature due to the thermal properties of masses. They are also likely to benefit from the release of heat from buildings through walls and windows. Plants will be less prone to frost damage and their growing seasons extended. Obviously, consideration has to be given to preserving the structural integrity of buildings and maximum loads for roofs (See Technical).

Unfortunately, the urban environment is not fully utilised in an efficient and sustainable way. No reliable estimates are available as yet, but the area of flat roof space in towns and cities in developed countries must run into tens of thousands of acres. Taken with the sides of buildings, this represents an enormous, under-utilised resource. Urban areas could produce significantly more food because of the amount of surface that is available and the [biological] intensity of production[4]. The potential is further increased when we consider how much can be grown indoors or with protection.

There are numerous benefits of 'edible buildings' but also many barriers and limitations to their installation and operation, some of which we examine next.

[1] UNDP, Urban Agriculture –Food, Jobs and Sustainable Cities, UNDP, 1996
[2] B. Mollison, Permaculture Design Manual, Tagari Press, 1991
[3] B. Mollison, Permaculture Design Manual, Tagari Press, 1991
[4] B. Mollison, Permaculture for urban areas and urban rural links, Yankee Permaculture, 1981

Benefits, challenges and limitations

Environmental

The environmental benefits of 'edible buildings' include; the production of locally grown food [reduction in 'food miles'], the benefits to biodiversity (See Use), the protection of surfaces from the elements, increased thermal insulation of buildings, macro and micro temperature regulation, and mitigation and adaptation of climate change[5]. They may also include improved sound insulation and control of soil and growing mediums, and of possible pollutants such as fertilisers and pesticides. If composting of plant and/or animal wastes takes place, nutrients will be recycled locally and waste assimilated to provide soils and mediums for, and organic fertilisation of, crops. Roof and vertical gardens can also assist storm water management and improvement of air quality through filtration of particles by plants.

Unfortunately, contamination of food via the air, water and soil can be a serious obstacle to food growing in urban areas because of both real and perceived threats. Produce grown in front gardens is thought to be particularly vulnerable to contamination by vehicle emissions although a study by Birmingham University[6] found that this is largely superficial -easily resolved by thorough washing and the removal of outer layers of foods. Research by Cornell University in New York and the Russian State Committee on Standards suggests that food grown on rooftops and terraces is significantly less contaminated than that grown in sub-urban plots or bought at local markets[7]. Certain strategies and techniques such as the choice of crops, use of raised beds and green pollution barriers, and increases in soil alkalinity, are thought to assist contamination abatement and remediation[8].

Social

'Edible buildings' can help improve the aesthetics of urban areas and increase participation of the community. Residents living in Apple Tree Court in Salford, England started to green their estate in 1988 and now have a productive garden with allotments, polytunnels and composting. This has brought about a positive change in the community and they have gained confidence to develop other initiatives.

Everyone lives in buildings and a majority in the North work in them. Those without a front or back garden, or in close proximity to allotments or community garden, still have the opportunity to garden and grow food where they live and work. Generally, less affluent households are likely to have less surplus space in which to grow food. These inequalities reflect those found in society in general. Deprived communities and households may partly overcome this problem by utilising all available areas and surfaces in homes and on estates.

Tenure in and around buildings is generally more stable and secure compared with other urban food growing locations[9]. Participants can therefore plan further into the future and develop larger capital improvement projects.

[5] S. Peck &C.Callaghan, Greenbacks from Green Roofs: Forging a new industry in Canada, Peck & Associates, 1999
[6] personal communication with Clive Birch, Chairman of Birmingham District Allotments Council, April 2000.
[7] UNDP, Urban Agriculture –Food, Jobs and Sustainable Cities, UNDP, 1996
[8] T. Garnett, City Harvest–the feasibility of growing more food in London, Sustain: The alliance for better food and farming, 1999
[9] UNDP, Urban Agriculture; Food, Jobs and Sustainable Cities, UNDP, 1996

Food that is harvested from household gardens is also likely to be fresher when consumed, as it travels direct from the garden to kitchen and/or to be processed. This increases the likelihood of higher amounts of vitamins and beneficial enzymes being present when it is consumed by householders and may help to improve diet and nutritional intake.

Security is a major concern of people, especially in deprived inner city neighbourhoods. Front and communal gardens tend to be more prone to theft and vandalism compared with private, back and roof gardens[10]. However, they are all likely to be less prone than distant areas given that similar conditions apply.

Economic

There are many economic benefits of 'edible buildings' with a number related to aspects already discussed (See Environmental). Non-commercial participants will benefit from a fungible income through a reduction in purchases of food from markets. Cost savings may occur through the increased insulation of buildings [reducing energy bills], protection of surfaces [extending the life of walls and roofs, thereby reducing maintenance and replacement costs], and reduced need for storm water infrastructure and management[11]

Additionally, the proximity to home and work saves time and effort[12] and reduces participants' incidental costs incurred by travelling to and from sites further afield [shoe leather costs]. Employment and training opportunities can be increased in the food economy and in auxiliary industries such as plant nurseries, roofing manufacturers and landscape architecture businesses. Improvements in air quality may lead to improvements in the health of residents and productivity of workers resulting in cost savings accrued to individuals, Government health departments and companies.

However, 'edible buildings' and especially roof gardens can have high initial costs especially if the building's structure needs to be modified. Costs of consultants, insurance, maintenance and materials can be a barrier to their initiation and development[13]. Insurance costs can be high due to a lack of historic information about terrace, roof and balcony installations. Furthermore, most of the cost savings will accrue over a number of years and are therefore likely to be heavily discounted.

Technical

Technical challenges to growing food in conjunction with buildings include the suitability of the existing surfaces for plants, the possible impact of root penetration especially from trees if membranes are damaged during installation, and the limitation of types of crop available for use due to the soil systems employed.

Sites such as balconies, terraces and roof gardens need particular consideration of their maximum loads. Maximum loads are calculated by summing the 'live' load including people, snow, wind, etc, and the 'dead' load including the roof itself, roof membranes and growing mediums when saturated. Professional help is advisable in such instances although this is likely to increase the cost of installation.

[10] UNDP, Urban Agriculture; Food, Jobs and Sustainable Cities, UNDP, 1996
[11] S. Peck &C.Callaghan, Greenbacks from Green Roofs: Forging a new industry in Canada, Peck & Associates, 1999
[12] UNDP, Urban Agriculture, Food, Jobs and Sustainable Cities, UNDP, 1996
[13] S. Peck &C.Callaghan, Greenbacks from Green Roofs: Forging a new industry in Canada, Peck & Associates, 1999

Small to medium sized trees can be grown in large containers. However, they need to be weighted or securely attached to the building if they are vulnerable to strong winds. Both containerised trees and windbreaks may add to the 'dead' or 'live' load of the building respectively -advice should be sought if considered necessary.

Informational

The creation of 'edible buildings' can be hampered by a lack of awareness and information by participants, policy makers, academics, professionals and other stakeholders. It can also be hampered by misconceptions by the public at large. The view that climbing plants will damage surfaces, or that the roots of plants will damage the foundations of can be correct in certain instances (see paragraph note) although major problems are rare and can be largely mitigated by following appropriate designs and strategies. Education and awareness raising of these aspects are necessary to overcome misconceptions and shortages of information.

[Damage to walls may be accelerated by climbing plants if they have already started to decay. Foundations may be damaged by trees with vigorous roots, it is advisable to plant trees with small rootstocks and/or with a root barrier in between. It is recommended that climbers be planted at least 40cm away from any wall so that their roots do not affect the foundations.[14]]

Regulatory

Building standards vary across borders and can be used to encourage the greening of buildings and improve their ease of use for growing food. Regulations in some parts of Germany have required new developments to install green design aspects and technologies. Costs are likely to be minimised if the appropriate structures and systems are in place from the beginning.

Planning regulations can benefit or be barriers to 'edible buildings'. If poorly designed developments are granted planning permission this can lead to difficulties in starting and developing food growing. Alternatively, developments that are ecologically designed, including the maximisation of areas for planting and creation of sheltered microclimates, will aid sustainable food production. Planning permission is sometimes required for structural work and for greenhouses and conservatories if they are over a certain size –this can lead to delays and increases in cost.

Planning guidance can be a barrier to roof and 'vertical' gardens on buildings where they would overlook other private gardens and residences. Planners have to consider people's privacy and can be reluctant to grant a change of use of the roof of buildings[15]. However, most people establishing a roof or vertical garden would also value their privacy and they are likely to use trellising and screens to provide this.

Health and safety regulations including those for fire are there to protect life and minimise injuries. It is best for participants to seek advice on health and safety from statutory bodies. In the UK, appropriate fire exits and a minimum 1.5 metre high fence or wall, around the edge of roofs are required if the public have access. If modifications are required, adherence to regulations will obviously increase the cost of installation.

[14] J. Johnston and J.Newton, Building Green, London Ecology Unit, 1985
[15] personal communication with Justin Bere, Architect

Operational

The cost of plants and materials can be a barrier to the installation and development of 'edible buildings' as well as any structural adjustments (See Economic). Installation and maintenance can be made more difficult if heavy loads need to be transported to higher locations. If labour is limited for such tasks, hoists, lifts and winches can be employed.

Access to the outsides of buildings is occasionally required for repairs and painting. Plants can be damaged in these processes by scaffolding, paint and people. Inappropriate maintenance, as well as burrowing animals, may cause damage to the bases of sites.

The urban environment, including homes and workplaces, makes water more available for harvesting and irrigation[16]. As well as piped water supplies, rain drainage systems can direct water to storage tanks to be used for plant irrigation. Household wastewater can be remediated with the use of reedbeds and similarly used in the garden.

On balconies and rooftop gardens wind speeds are greater than those on the ground. Crops which tolerate such conditions are appropriate whilst others will require greater protection from the negative effects of strong and desiccating winds[17]. Food plants also need protection from the sun and heat particularly if grown in a greenhouse during summer months. Plants generally require more frequent watering and fertilisation if grown in arid conditions, containers or shallow beds.

The garden design and choice of plantings will depend on many factors including the aspect and orientation, final size, personal taste, climates, disease resistance, etc. Gardening techniques will be the same as general areas although certain aspects will have a greater emphasis. A good proportion of food grown in urban areas will be grown in containers. Crops are also likely to have similar allies and foes to others in more conventional gardening locations although differences will occur due to the location and environment. For example, carrots grown on balconies or rooftops may suffer less from carrot root fly whilst brassicas may be more prone to damage by pigeons.

Animal keeping is also practised on and around buildings although less so in the North. Poultry and livestock are kept for their fresh meat, milk, and eggs, -providing the householders with some of their essentials. Animals require at least twice daily feeding and watering as well as weekly, monthly and yearly tasks, which limits their potential especially where participants have neither the time nor the inclination. Microlivestock are perhaps more suitable especially if space and time are limited. Apiculture is considered to have fewer limitations. Bees produce greater quantities of honey in urban areas[18], require a space of only $2m^2$ per hive, and have minimal maintenance and low cost of equipment. Aquaculture systems also have potential for 'edible buildings' although there is limited information on this aspect.

The greatest potential regarding roofs and terraces obviously lies in accessible, intensive roofs and terraces which can tolerate deeper soils and mediums. Lower weight systems such as hybrid hydroponics and hydroponics can be employed if loads are restricted. Even inaccessible, extensive roofs can be used for food production in an indirect way. Green roofs with bee forage and other insect attracting plants would increase honey yields and assist a balanced garden ecology.

[16] UNDP, Urban Agriculture, Food, Jobs and Sustainable Cities, UNDP, 1996
[17] M. Don, Life, The Observer Magazine, 5.12.99
[18] Norman Carreck, Institute of Arable Crop Research, Rothmanstead, 1999

Use

Much of the urban surface in courtyards, around buildings and estates is unutilised or under-utilised. Competition for space with other economic or recreational activities can occur although most sites are likely to be unused or have mixed usage. Spaces can be used for activities such as commercial operations, energy generation (including photovoltaics), household activities such as drying washing, and children's play. However, gardening is very popular and plants and gardens are generally seen as desirable not least in homes and at work.

The use of artificial pesticides and other biocides in the garden will have negative effect upon the organisms that live there and upon the wider environment, and could have potential health risks to humans. Food growing activities, when they include ecological principles and organic practices, increase the biodiversity of wildlife and plant varieties. Ponds, animals, plants and soils will enhance the diversity and variation of both species and habitats and may form parts of 'green corridors' or distinct islands within the city.

Conclusion

Growing food in cities and the built environment, whether as a livelihood or for enjoyment, can contribute to food security and urban sustainability. The general 'greening' of urban areas must be encouraged and implemented by practitioners and policy makers. The many benefits associated with this, to the environment, to people's health and well-being, as well as providing the necessary conditions for food growing activities to thrive, should not be ignored by professionals and laymen alike.

At the same time, however, we must recognise that if cities are to be sustainable, links must be made with the urban fringe and surrounding rural areas. Built environments do offer large surface areas for food production but how much is practically utilisable remains debatable. Farms, allotments and imports provide the bulk of cities food and will for the foreseeable future. Opportunities do exist for food production in association with buildings and other structures but we must be aware of the difficulties and challenges that this unique situation brings.

Glossary

Agritecture	-'the practice and study of food production using buildings and other structures'
Annidation	-'layering and timing of plants to utilise all available space and time'
Apiculture	-'beekeeping for honey and other products'
Aquaculture	-'use of water resources for agricultural production'
Companion Planting	-'planting crops together which have a symbiotic relationship'
Discounting	-'reduction in the present value of income and costs because accrual is in the future'
Food Miles	-'the distance which food travels down the food chain, from primary production to retail and consumption'
Fungible income	-'income saved by substitution of purchased goods and services'
Guilds	-'associations or groups of animals and plants which have a symbiotic and synergistic relationship'
Intercropping	-'production of more than one crop in the same space'
Microlivestock	'small livestock including guinea pigs, rabbits and poultry'
Organic agriculture	-'agriculture that does not use artificial chemicals or monocultural practices'. Its philosophy is to feed the soil to feed the plants to feed the animals'
Permaculture	-'ecological design for landscapes, buildings, gardens, economies and communities'
Shoe Leather Costs	-'incidental costs incurred by travelling'

Note:

Sustain: The alliance for better food and farming (formerly the National Food Alliance and the SAFE Alliance) advocates food and agriculture policies and practices that enhance the health and welfare of people and animals, improve the working and living environment, promote equity, and enrich society and culture. Sustain represents over 100 national public interest organisations working at international, national, regional and local level. James Petts is an economist and currently the project co-ordinator for City Harvest –Sustain's Urban Agriculture programme.

Disclaimer:

This paper is based on the author's own experience and a review of research and projects concerning urban food production in association with the built environment. It is not to be cited or referenced without the author's permission. It does not necessarily represent the views of Sustain or any of Sustain's members. Although it contains some useful insights into the subject, for more technical aspects, it is for the reader to ensure that any necessary professional help is sought before any practical work is conducted. Sustain will be conducting a more in depth study and disseminating the results during the course of its *Edible Buildings'* project.