"Edible" urban forests as part of inclusive, sustainable cities

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Urban and peri-urban forests can produce a range of foods to supplement local diets and provide a focus for community activity.

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Feeding an increasingly urban population and ensuring the economic and social well-being of urban dwellers will be the primary challenge for cities in coming decades. The impacts of climate change are expected to slow down urban economic growth, exacerbate environmental degradation, increase poverty and erode urban food security. Many cities are on a quest for more sustainable urbanization pathways that will enable effective responses to the increasing socio-economic and environmental challenges they face.

In the search to "make cities and human settlements inclusive, safe, resilient and sustainable" (Sustainable Development Goal 11 in the United Nations Sustainable Development Agenda 2030), interest is increasing in growing local food. Edible green infrastructure, mainly in the form of urban food forests and trees (referred to here generally as urban food forests and also sometimes as tree-based edible landscaping), can help address a range of problems caused by rapid and unplanned urbanization, such as food scarcity, poverty, the deterioration of human health and well-being, air pollution, and biodiversity loss (FAO, 2016).

The use of edible plants in urban and peri-urban forestry varies among cities and is influenced by historical, cultural and socio-economic factors. Overall, it has tended to be neglected in modern cities.

Above: The pomegranate* (Punica granatum) *– "granada" in Spanish – is the heraldic symbol of the city of Granada, Spain, where it appears on streets throughout the town. It produces a highly nutritious fruit

This article explores the potential of urban and peri-urban forests as sources of food and the role that urban food forests can play in fostering sustainable cities.

WHAT ARE URBAN FOOD FORESTS?

Clark and Nicholas (2013) defined urban food forests and trees as "the intentional and strategic use of woody perennial food-producing species in edible urban landscapes to improve the sustainability and resilience of urban communities". As an "edible landscaping" practice, urban food forestry involves a combination of agriculture, forestry and agroforestry in urban areas to supply cities with food. It may involve various species of fruit and nut trees, berry bushes, vegetables, herbs, edible flowers and other ornamental plants.

The integration of urban food forests into the infrastructure of a city can provide urban dwellers with many benefits. There is evidence that urban food forests can motivate stewardship practices and give inhabitants opportunities to interact with nature and each other (McLain *et al*., 2012); enable the development of more resilient food systems and promote social and environmental sustainability (Yates, 2014); improve social cohesion and well-being and strengthen local communities (Lwasa *et al*., 2015); enhance biodiversity (Dennis and James, 2016); and provide economic benefits for both municipalities and citizens (Lafontaine-Messier, Gélinas and Olivier, 2016).

Tree-based edible landscaping in urban areas has been practised since ancient times. Ancient Egyptian and Persian gardens combined fruit trees with flowers, ponds, pot plants, vine-clad pergolas and places to sit in winter sun or summer shade. Classical ornamental gardens had water channels, pools, fountains and cascades cooling the air, flowers producing scents, and fruit trees providing food and shade. Medieval monastic gardens produced fresh fruit and vegetables, as well as flowers and medicinal herbs. Renaissance estates had plots and terracotta pots for growing flowers and producing fruit, vegetables and herbs that were sold locally to raise funds for maintenance.

In the Industrial Revolution in the nineteenth century, however, the edible elements of urban landscapes tended to be replaced by ornamental vegetation. Today, most cityscapes are largely devoid of edible components and instead feature traditional shade trees, lawns and other soil-cover plantings.

Urban food forest typologies are influenced by city histories. In Central America, for example, native gardens of multistrata agroforestry systems coexist with colonial cityscapes featuring large trees and exotic plants (González-García and Gómez-Sal, 2008). Socio-economic circumstances may also play a role: in Berlin, Germany, the estimated fruit-tree density is still significantly higher in the eastern part of the city than in the west (8.6 trees/ha versus 1.6 trees/ha) (Larondelle and Strohbach, 2016).

EFFORTS TO APPLY URBAN FOOD FORESTRY WORLDWIDE

The applicability of urban food forestry and its efficacy in addressing social and environmental challenges depend on a range of social, environmental and other local factors. Only a few examples exist of modern efforts to encourage urban food forestry, and these are mostly limited to relatively small urban settings.

In Todmorden, West Yorkshire, in the United Kingdom of Great Britain and Northern Ireland, volunteers grow fruit, herbs and vegetables for everyone to share; they do so without paid staff, buildings or funding from statutory organizations. The volunteers also run events to help strengthen the local community; income is generated through donations and fees for talks and tours (Incredible Edible Todmorden, undated). In Copenhagen, Denmark, in contrast, citizens do not collect fruit from urban forests because it is widely perceived that doing so would break social norms (Yates, 2014).

United States of America

Among examples of urban food forestry in the United States of America, Seattle's urban food forest (McLain *et al*., 2012) is probably the best-studied. Seattle Public Utilities owns the Beacon Food Forest, but the forest's fruit trees were planted by community volunteers, many of whom continue to work in the forest and maintain the orchards. Ongoing participation gives community members a sense of stewardship and pride in the space.

Lemon Grove – a municipality of 26 000 inhabitants in California – is preparing to grow public orchards in city parks as part of efforts to preserve the city's history and small-town charm. Issues to be addressed in selecting sites for fruit trees include proximity to roadways and sidewalks; accessibility for mobility-impaired individuals; access for maintenance; and input from community members and garden experts (Federman, 2017).

The San Francisco Urban Orchard Project provides ongoing resources for the planting and maintenance of publicly accessible fruit trees. The programme partners with local not-for-profit organizations to plant fruit- and nut-tree orchards and to assist community-based groups in their roles as local stewards of green spaces (SF Environment, undated).

Barnum is one of eight city parks in Denver, Colorado, with urban orchards. It is in what used to be one of the city's least desirable neighbourhoods, but things took a turn for the better when Denver Urban Gardens – a not-for-profit organization that supports community gardens in the city – purchased a vacant lot. This is now a community orchard that grows red currants, raspberries, grapes and winter squash among fruit trees (Extreme Community Makeover, 2016).

Developing countries

Rapid urbanization in many developing countries is leading to increased urban poverty and pressure on green spaces. Edible landscaping is often in the form of small-scale subsistence agriculture, and such gardens represent significant proportions of urban green infrastructure. Even in inner-city areas, residents cultivate

roadsides and riverbanks, along railroads, on vacant private lands and in parks, based on minimal user rights such as informal rents, leases and inheritances. In Taipei, Taiwan Province of China, however, the law forbids the planting of fruit trees and vegetables in parks and public spaces (Chang *et al*., 2016).

Disputes arise about who can plant, harvest or otherwise use urban forests when laws or ordinances do not specify rights for the use of common areas (Rana, 2008). Fear of eviction is a strong disincentive for people to introduce food trees and shrubs. In illegal settlements in Kathmandu and Lalitpur, Nepal, people grow seasonal food crops but do not care for "doubt tenure" trees. In South Africa, homestead fruit and nut trees are important sources of food, especially in informal settlements, where the poorest people live. Residents of new low-cost housing make especially extensive use of urban tree products harvested in public urban spaces because they have fewer homestead trees than residents in informal areas and townships (Kaoma and Shackleton, 2014).

Urban food forestry is not widely implemented in Asia and the Pacific, but innovative urban forestry practices are evolving in the region (Kuchelmeister, 1998). In China, residents can harvest fruit in many parks; in Queensland, Australia, residents and schools maintain edible public parks, producing fruit, herbs, flowers and vegetables (Kuchelmeister, 1998).

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An educational initiative in Chinandega, Nicaragua, is designed to help protect urban fruit trees, such as this large mango tree* (Mangifera indica). *Fruit trees are common in indigenous neighbourhoods in Central America

Africa

Agroforestry gardens are probably the most significant type of urban green space in West African countries (Fuwape and Onyekwelu, 2011). In arid and semiarid areas, it is common practice to establish windbreaks to protect urban areas and enhance soil productivity (Kuchelmeister, 1998). Urban forest practices that contribute to food security include collecting wild edible plants, planting fruit-bearing street trees, and establishing medicinal public parks. Fruit trees are planted in many residential compounds, especially those on urban fringes and in new urban settlements.

Despite the marked differences in the sociospatial and environmental settings of Botswana, Cameroon, Côte d'Ivoire, South Africa and the United Republic of Tanzania, wild food trees are integral to most urban and peri-urban households in small and mid-sized cities in those countries. This applies not only to poor families lacking access to productive soils

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In public areas of impoverished districts in Cabo Verde, people plant, care for and protect fruit trees in preference to ornamental trees

but also to those with a higher standard of living (Schlesinger, Drescher and Shackleton, 2015). A study in Senegal nearly three decades ago (Brun, Reynaud and Chevassus-Agnes, 1989) found that urban food forests did not make a significant contribution to food consumption and nutrition but were instrumental in improving the income and social status of women and increasing their awareness of evolving food habits in urban areas.

In Cabo Verde, the extent of urban food forestry varies according to the actors involved. Trees planted and managed by municipalities are mostly ornamental, while those planted and cared for by residents are usually fruit trees (e.g. *Carica papaya*, *Mangifera indica* and *Terminalia catappa*).

ISSUES FACING URBAN FOOD FORESTS AND TREES

Research and literature on urban food forestry are scarce, despite the long history of growing forest foods in urban areas. Most existing studies report specific cases of local food production from urban food forests, and there have been few attempts to explore the adaptation and application of local practices in other contexts or to scale them up. The lack of research probably reflects the general bias of studies on urban ecosystem services in western Europe and North America, where cities today depend mostly on outside sources of food (Larondelle and Strohbach, 2016). Although edible urban landscapes were widely used for centuries in the European Mediterranean, the contributions of such landscapes to the livelihoods of modern urban communities are far from fully explored. Of existing experiments, none has explicitly addressed the food-provisioning aspects of urban trees (Valette, Perrin and Soulard, 2012). A recent review of urban food forestry collected information on 37 initiatives worldwide (Clark and Nicholas, 2013): it evaluated 30 urban forest master plans in various cities and found that human food security was a primary objective in only four of them.

Russo *et al*. (2017) analysed more than 80 peer-reviewed publications focusing on urban ecosystem services and disservices. They identified eight typologies of edible green infrastructure, including edible forest gardens and edible urban forests, which were addressed in 38 percent of the publications. Some publications showed urban food forestry to be a multifunctional urban landscape practice combining an extended range of ecosystem services efficiently in cities and integrating the provision of food with environmental, sanitary, social, cultural and economic co-benefits. Evidence of the trade-offs between the supporting, provisioning, regulating and cultural services of urban food forests is lacking, however.

Also lacking is a conceptual framework that would enable the synthesis and analysis of existing knowledge on urban food forestry. Such a framework is needed to integrate the relevant aspects of urban food forestry into urban planning, such as the area required, species, knowledge,

management, governance, and financial and human resources. As to the area needed, Richardson and Moskal (2016) calculated that a 58-km buffer around Seattle would be required to meet 100 percent of the city's food needs.

In most countries, the actual and potential contribution of urban food forestry to sustainable and resilient urban development models is unknown. Although research into, and the practice of, urban agriculture is growing, urban food forestry has been implemented systematically in only a few countries, and its practices are little explored.

Risks of urban food forestry

Certain risks are associated with the implementation of urban food forestry. Poe *et al*. (2013), for example, pointed out that the toxicological profiles of urban soils should be investigated before they are used for urban food forestry to avoid health risks posed by the uptake by plants of pollutants such as heavy metals. Species selection and cultural techniques can also help prevent the accumulation of pollutants in the edible parts of plants: the translocation of pollutants absorbed by roots to edible parts, as well as the amount of airborne pollutants penetrating the fruit epicarp, has been shown to differ widely by species (von Hoffen and Säumel, 2014).

Vegetables from urban and peri-urban farming may contain unacceptable quantities of trace elements (Nabulo *et al*., 2012; Samsøe-Petersen *et al*., 2002; Säumel *et al*., 2012); on the other hand, some studies have found it possible to produce healthy food from fruit trees grown along streets in large cities (von Hoffen and Säumel, 2014). The apparent discrepancy between studies on the health risks of urban food forestry may be due to soil characteristics and the plant species used.

Another health risk that can occur from the consumption of raw fruit produced in urban food forests is an allergic reaction known as oral allergy syndrome. This can occur in sensitized individuals due to cross-reactions between aeroallergens and food allergens – such as between pollen produced by species in the Cupressaceae family and the fruit of *Prunus persica*, giving rise to "cypress–peach syndrome" (Popescu, 2015).

Unharvested fruit can be hazardous and unsightly when they drop from trees, and they can also attract vermin and pests. Highly perishable crops require quick processing, such as canning, freezing or drying, or sufficient people to quickly consume surplus supplies (Brown, 2016).

Most widely used fruit tree species belong to only a few families or genera

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Orange trees planted as part of a new urban development in Porto, Portugal. Urban food forestry involves a combination of urban agriculture, forestry and agroforestry techniques and strategies

(e.g. Rosaceae in temperate environments). But the use of a small number of species may challenge the 30–20–10 biodiversity rule proposed by Santamour (1990) to maximize protection against pest outbreaks.[1] Many commonly grown fruit trees are indeed very sensitive to pests and pathogens, but this can be managed through wise, inventory-based species selection. New releases and the restoration of ancient resistant cultivars of widely used species, as well as the use of minor, neglected species with edible uses, might help improve the tolerance of urban food forests to pests and diseases.

Urban food forestry strategies

The development of an urban food forestry strategy requires a broad range of expertise to ensure a comprehensive approach. It involves the integration of knowledge from social and environmental sciences and disciplines such as urban forestry and arboriculture, urban agriculture, urban ecology, landscape and urban architecture, economics, policy and governance. Effective, efficient collaboration among experts, policymakers, local governments, the private sector and citizens is essential to ensure effective urban food forestry.

CONCLUSION

The examples in this article show that urban food forestry can be applied in diverse contexts and to meet various objectives. Urban food forests and trees are located mostly on formal and informal public land, and implementing an urban food forest approach depends on ownership, local rules, norms, policies, and an effective governance model. Comparative studies and lessons learned are needed to understand the most effective approaches in different contexts.

The consideration of urban food forests and trees and their integration into regional, national and local urban policies can provide a pathway towards sustainable urban development. Developed countries have started to rediscover urban tree-based edible landscaping but, in most cases, food production is still not the primary objective of urban and peri-urban forestry. In developing countries, knowledge gaps need to be identified to stimulate research on strategies to consolidate traditional models of tree-based edible landscaping and to foster new approaches.

The potential of urban food forests is still far from adequately exploited, and there is a need to develop modelling tools, advanced design principles, and efficient management and governance strategies. Initiatives are needed to gather knowledge on existing efforts and to fully assess issues associated with food safety, such as the risks posed by soil, water and air pollution.

Further research is needed to identify the species, compositions and configurations that will maximize the benefits of urban food forests for local communities and minimize the risks to human health. Cultivars and genotypes are needed that are adapted to harsh urban environments, especially in the context of climate change.

Collaboration – subnationally, nationally and internationally – among scientists, citizens, policymakers and city managers is crucial for establishing a robust conceptual framework for urban food forests. It is also desirable to compile traditional tree-based edible landscaping practices to guide the design of projects in which food production is the central objective. Urban food forests are potentially a valuable multifunctional component of the broader green infrastructure of the cities of the future and can help achieve the Sustainable Development Goals. ◆

[1] Under this rule, no more than 30 percent of trees in the same family, 20 percent of trees in the same genus, and 10 percent of the same species should be planted. See also the article on page 11.

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