Science Societies

Urban agroforestry and its potential integration into city planning efforts

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Source: UC Davis Arboretum and Public Garden.

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Interest in urban agriculture continues to expand as a broad array of benefits are documented by researchers and practitioners. Landscape designers and urban planners are encouraged to purposefully integrate food production into the fabric of the city, using a multifunctional landscape approach that recognizes the value of ecological and cultural functions, beyond the simple metric of food production (Lovell, 2010). Despite the growing awareness and visionary proposals for the implementation of urban agriculture, we have yet to see broad integration in the urban environment. In most cities, the level of food production has not expanded in a meaningful way that

would significantly impact the supply of vegetables, fruits, or other products.

Source: Adobe Stock/dvoevnore.

Widespread adoption of urban agriculture has likely been limited by a number of critical barriers. Land access can be an issue, particularly when property values are high or future development is anticipated. Zoning and tax policies often prohibit or restrict food production (Angotti, 2015) or foraging of edible and medicinal plant products from existing green spaces (Shackleton, Hurley, Dahlberg, Emery, & Nagendra, 2017). Another enormous barrier is the risk (real or perceived) related to soil and air contaminants tainting the edible products grown in urban environments (Wortman & Lovell, 2013). Finally, the emphasis on annual vegetables in most urban agriculture systems may come into conflict with other greening initiatives such as those promoting tree canopy cover across the city (Taylor, Lovell, Wortman, & Chan, 2017). Contributing to this conflict, urban forestry plans regularly neglect the topic of food security entirely, ignoring the potential for trees and shrubs to contribute edible products (Clark & Nicholas, 2014).

Defining Urban Agroforestry

Urban agroforestry (UAF) systems that include productive trees and shrubs may offer an alternative solution with potential to overcome these critical barriers. Rather than replacing or competing with annual food production systems that dominate the literature and the on-the-ground applications, UAF instead could complement them by emphasizing perennial woody plants that offer edible products. Mixtures of different species of nut or fruit trees, berry shrubs, and other crops are designed as

"multifunctional woody polycultures" that supply food and a broad array of other ecosystem services that are well documented in various forms of diverse perennial plantings (Lovell et al., 2017).

Several variations on this concept are emerging in the scientific literature and popular culture. The term **permaculture** comes from "permanent agriculture" and encourages purposeful design of landscapes to reflect the patterns found in nature and to supply food or other useful materials (Ferguson & Lovell, 2014). **Edible forest gardens** use a similar definition with a focus on perennial polycultures with plants that occupy different layers, including some plants that serve a support role to supply nutrients, physical structure, or other benefits for the nearby plants (Jacke & Toensmeier, 2005). The **food forest** and **urban food forestry** concepts also encourage the use of food-producing species, and some definitions emphasize the capacity for improving urban community resilience (Clark & Nicholas, 2014).

Source: Flickr/Alderleaf Wilderness College.

Strategy to Advance Food Production

Urban agroforestry could serve as a progressive form of urban agriculture if the productive woody species are better integrated with other urban planning initiatives that promote sustainability, multifunctionality, and resilience for the community. The perennial nature of the tree and shrub species would provide a stronger "sense of place" or permanence, which might help to protect the plantings from development or competition from other land uses. People tend to prefer landscapes that include trees, so the community itself could offer further support. Integration of UAF into city parks and other public spaces

would better secure the long-term commitment to these plantings and their proper maintenance. By simultaneously aligning zoning and tax policies in cities to allow—and even encourage—a production component, the potential for edible landscaping could be normalized (McLain, Poe, Hurley, Lecompte-Mastenbrook, & Emery, 2012).

The issue of soil contamination might also be substantially reduced in UAF compared with annual production systems. Trees and shrubs produce fruits and nuts that are spatially separated from the contaminated media, so there is less likelihood of soil particles adhering to the edible portions, particularly compared with root crops or low-growing leafy vegetables. Since many contaminants (e.g., heavy metals) can be mostly immobilized by complexes in the soil, the concentrations translocated to edible portions of trees and shrubs (fruits/nuts) are likely to be low. Research on this topic is limited, so considerably more work is needed to truly understand the species-specific risks associated with this application. In the near term, areas known to contain high concentrations of contaminants might focus on non-edible materials such as textiles, dyes, cut flowers, and wood products.

Considering the broad scale of the city, UAF may offer an advantage over annual forms of urban agriculture due to the unique synergy with other urban resilience initiatives. Urban trees, as key components of green space, can help to modulate extreme weather events and disturbances such as flooding, strong winds, and heat waves. In addition to their role in climate change adaptation, urban trees offer a substantial mitigation strategy due to their potential to store carbon and reduce greenhouse gas emissions that result from alternative land use types that require greater inputs of fertilizer and maintenance activity (e.g., lawn mowing). By encouraging a focus on productive trees and shrubs, UAF can be highly compatible with other tree canopy initiatives designed to combat the effects of global warming.

Implementing the Novel Solution

Source: Will Parson/Chesapeake Bay Program.

The implementation of UAF offers exciting opportunities to build capacity for the production of healthy fruits and nuts that could be made available to communities most impacted by food insecurity. Urban agroforestry might be integrated right into the existing urban green spaces with purposeful plant selections. Urban foraging already occurs in cities across the globe (Shackleton et al., 2017), which suggests that in some sense, UAF already exists even if not intentionally planned. To expand and extend UAF to reach more residents and contribute to greater production, however, conversion of land is necessary. In many cases, marginal lands, vacant lots, and interstitial spaces that have less potential for commercial development would be reasonable options. Some benefits might be found in locating UAF sites in spaces connected to other complementary land uses such as urban vegetable farms, parks, cemeteries, and other green spaces. Synergies in land use or sharing of resources (e.g., water for irrigation) might arise as spatially adjacent properties are connected, allowing the benefits to be extended beyond a single site (Colding, 2007).

For land transformation, the use of a multi-strata, diverse planting design would allow for the inclusion of a wide range of edible and supporting species. The selection of specific species for these systems should include several key criteria: (1) well adapted to the local climate and urban environment, (2) low maintenance and low input, and (3) good capacity to promote human health. Poe, McLain, Emery, and Hurley (2013) suggest moving beyond simple “food justice” to consider “health justice” with foods for good nutrition and medicinal plants for remedies and ailments (Poe et al., 2013).

Some of the most nutrient-dense foods that are high in antioxidants can be grown on shrubs and trees in a variety of conditions and climates. The goal “low input” criteria are also related to the human health theme as the use of pesticides should be limited or avoided altogether on plants with products destined for human consumption.

If strategically designed and implemented, UAF can be promoted for the contribution to the overall health of the urban environment. Planting more trees is considered to be one of the most effective strategies for adapting to and mitigating climate change (Bastin et al., 2019), and many cities have developed specific targets for increasing their tree canopy cover and species diversity. The “Million Trees” programs started in the U.S. and has been adopted by New York City, Los Angeles, Miami, and others to recognize the value of urban forests that result from the wide range of ecosystem services they provide. Urban agroforestry could be aligned with these and other ecologically based planning goals such as stormwater mitigation and microclimate control (Clark & Nicholas, 2014; Lwasa et al., 2015).

Conclusion

The topic of UAF is ripe for further research, demonstration, and education. The potential risk associated with establishing plantings on contaminated sites is particularly understudied. However, even as gaps exist in our understanding of the performance of these systems, the translation of existing research could be an important step for implementing changes in the near term. Much of the information needed to make informed decisions for establishing UAF plantings is already available in the fields of agroforestry, plant science, and horticulture. Efforts to collect, summarize, and share this information could be rapidly rewarded with greater adoption and integration into urban planning initiatives. The establishment of UAF and

harvesting of food products from urban forests should be normalized and promoted as an expected component of the urban environment (McLain et al., 2012). With a visionary model built on realistic outputs, we might reimagine a “garden city” for a variable and uncertain future.

Call for Papers

An upcoming special issue of *Urban Agriculture & Regional Food Systems* will explore the topic of urban agroforestry. Can we safely grow food on trees and shrubs in urban settings to contribute to the food security of an increasingly urban population? What challenges will producers and consumers face and what unique opportunities could emerge in this new context for agroforestry? View the call for papers at **https://bit.ly/3f0eLha**. Submissions should be made via the *Urban Agriculture & Regional Food Systems* online submission portal: **https://mc.manuscriptcentral.com/urbanag**.

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