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COMMENT

Edible urbanism 5.0

Alessio Russo [1] & Giuseppe T. Cirella [2*]

ABSTRACT
Urban and peri-urban agriculture can have negative effects (i.e., ecosystem disservices) to the city ecosystem. In the last two decades, urbanists and landscape planners have promoted urban agriculture and food systems with little attention to ecosystem disservices. At present, increased urbanisation, environmental degradation, population growth and changes in food systems require a novel concept that considers trade-offs between ecosystem services and disservices. Considering the Sustainable Development Goal 2 of ending hunger and all forms of malnutrition by 2030, as well as the food revolution 5.0 of feeding up to ten billion people, edible urbanism 5.0 is a supportive component in reaching these goals. In this comment, edible urbanism via an edible green infrastructure (EGI) approach is examined against current urbanistic concepts that have common food production systems in cities. Moreover, a discussion on issues and challenges of public policy and governance for the implementation of sustainable food systems is shown with findings that consider current industrial intensive farming as somewhat unsustainable. Edible urbanism integrates three main principles of sustainability by fulfilling food security, resilience and social inclusion. It links site-specific, best-practices by integrating EGI-based governance with modernised food production techniques. Example cities showing EGI- and sustainability-oriented food concepts are presented. Recommendations for future edible urbanism (as a part of the next food revolution) are established.

[1] University of Gloucestershire, Cheltenham, UK. [2] University of Gdańsk, Sopot, Poland. *email: gt.cirella@ug.edu.pl

Introduction

Urban areas are increasingly feeling the effect of environmental degradation, climatic events, resource depletion, food insecurity, and economic instability (Beddington et al., 2012; UN Habitat, 2009). These phenomena are all factors that significantly reshape towns and cities and need to be addressed if urban landscapes are to be environmentally safe, economically productive and socially inclusive (UN Habitat, 2009). Inadequate access to healthy and affordable food, both in developed and developing countries, are a major cause for concern (Bedore, 2010; Lang and Miao, 2013; Vieira et al., 2018). Rapid population growth together with social and economic changes in many low- and middle-income countries have led to increased urbanisation and changes in food systems, lifestyles and eating habits (i.e., consuming processed foods with saturated fats, sugars and salt and low in fibre diets) (Beddington et al., 2012; FAO et al., 2018). This shift in nutritional status has augmented diet-related disease, stunting, wasting and obesity (FAO et al., 2018). In the last decade, there is a rising interest on the local food environment and its effects on health particularly in response to evidence of "food deserts" (Caspi et al., 2012). Such problems, unfortunately, will continue to trouble the poorer end of society with augmenting population and urbanisation. The growing costs of transporting food will increase the demand for urban agriculture spaces in cities by compelling planners with the task of integrating the urban open space system, as well as local, fresh food markets as standard elements of urban infrastructure (UN Habitat, 2009). In accordance with Sustainable Development Goal 2 to "end hunger, achieve food security, […] improve nutrition and promote sustainable agriculture," (United Nations, 2017) there is growing consensus by which this fundamental human need can be sustainably secured for all. Cities around the world have started to implement initiatives to re-design food provisioning (Hajzeri and Kwadwo, 2019; Sonnino, 2009). Most cities depend heavily on the global trade of food, and face a number of concerns in making urban food production transition due to the lack of arable land covered by factories, commercial buildings, housing and roads. It has become nearly impossible to convert this space back to agricultural production (Lang and Miao, 2013).

Significant knowledge gaps, which confirm the need for evidence-based sustainability metrics and standards, uncover tangible linkages between food security, human health, diet, nutrition, agricultural yield, resource use and environmental costs and benefits (Sonnino et al., 2018). Considering these challenges, the ability to feed cities in a just, sustainable and culturally appropriate manner—in the face of looming climatic events, widening inequality and burgeoning hunger—remains a quintessential issue of this century (Morgan, 2015). New urbanism approaches are needed. The concept of urban agriculture and city region food systems (Parham, 2015) in planning literature have expanded with terminology such as agricultural urbanism, agrarian urbanism, food urbanism, edible urbanism, edible green infrastructure (EGI; Russo et al., 2017), continuous productive urban landscape (CPUL), metropolitan agriculture, community agriculture, transition towns and networks, food markets and food-sensitive planning and design (Farr, 2012; Parham, 2012; Zeunert, 2018) (Supplementary Note 1). Urban gardening and urban social movements can build local ecological and social response capacity against major collapses in urban food supplies (Barthel et al., 2015). In tangent with the food revolution 5.0 of feeding ten billion people, we elucidate how edible urbanism via an edible green infrastructure (EGI) approach will change the urban makeup. An analysis of existing concepts in urbanism, associated with the applicability in providing food security in cities, buttresses the provision of edible urbanism 5.0 as part of this transformation.

Edible urbanism

Experts agree edible urbanism is not an officially coined term for urban agriculture, albeit it has been used to describe planning methodologies for incorporating food sheds and their associated system connections into the infrastructure systems of a city (Philips, 2013). For example, Gabrielle Esperdy used the term "edible urbanism" to identify the importance of food markets as a building type, which brings city dwellers in contact with fresh products and its sellers (Esperdy, 2002). In our definition, edible urbanism is derived as a planning concept of EGI. We define it to "a sustainable planned network of edible food components and structures, within the urban ecosystem, to manage and design the provisioning of ecosystem services" (Russo et al., 2017). Moreover, EGI is based upon one macro-category, EGI and urban agriculture, as well as eight sub-classifications utilising Russo et al.'s EGI topologies: (1) edible urban forests and edible urban greening, (2) edible forest gardens, (3) historic gardens and parks and botanic gardens, (4) school gardens, (5) allotment gardens and community gardens, (6) domestic and home gardens, (7) edible green roofs and vegetable rain gardens and (8) edible green walls and facades (Fig. 1) (Russo and Cirella, 2018b; Russo et al., 2017). As such, it also includes the foraging in urban ecosystems (McLain et al., 2014) and informal green space (Rupprecht and Byrne, 2014) (Supplementary Note 2). Edible urbanism is a socio-ecological approach to health and wellbeing that can prevent malnutrition and other alimentary diseases. The concept overlaps with urban agriculture but does not include animal husbandry, aquaculture or industrial intensive farming due to environmental costs and sustainability concerns (Russo et al., 2017).

Urban agriculture and EGI integrate a three-pillar approach of sustainability, incorporating: (1) environmental health (i.e., to support environmental wellbeing via low input of water and low to no use of fertilisers and pesticides); (2) social wellness (i.e., to provide social interaction and individual recreational

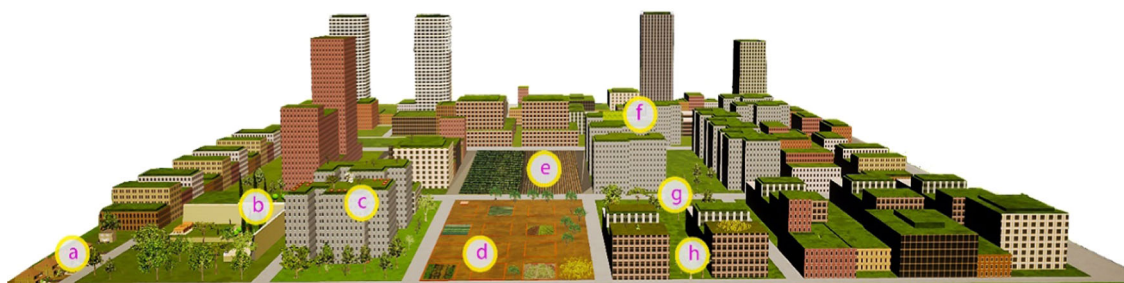**Fig. 1 Representative EGI categories within a city. a** Domestic garden, **b** historic garden, **c** edible green roof, **d** community garden, **e** urban agriculture, **f** edible green wall, **g** edible urban forest and **h** forest garden.

opportunities); and (3) economic profitability (i.e., to reduce transportation costs of shipping between local producers and local markets) (Krishnan et al., 2016). Urban agriculture and EGI can play a unique role in sustainability by linking urban growers and consumers in a common system that is mutually supportive (Palmer, 2018). The recent movement toward developing an "edible" green-based society, with formal and informal elements, links urban green space development with food issues driven by grassroots movements and urban administrations (Fischer et al., 2018; Russo et al., 2017). Urban agriculture and EGI can use applied sustainable regenerative principles to better urban environments. An example of this is the EGI regeneration project fulfilled at De Filippo Park in Ponticelli, an eastern suburb of Naples, Italy, "one of the most degraded, overcrowded and per-meated crime-ridden areas of the city" (Russo and Cirella, 2018a). This degraded suburb was transformed into a variety of allotment gardens, which provision EGI, in the form of gardening of vegetable crops, spurring positive feedback from the community (Russo and Cirella, 2018a). Likewise, urban growers in Baltimore, Chicago and New York examined similar social-oriented ele-ments with encouraging findings relayed from non-profits, community centres, churches, schools and social amenities in close approximation to the urban farms (Bennett and Lovell, 2019; Clucas et al., 2018; Egerer et al., 2017). Edible urbanism can facilitate a unique part in sustainability by networking urban agronomists and consumers in a common food system that is mutually assuring (Lang and Miao, 2013). As Senior Fellow Lisa Palmer, from the National Socio-Environmental Synthesis Centre in Annapolis, MD, USA, explains, "suburban and peri-urban farmers gain urban market share and improved viability through seasonal subscription-oriented community-supported agriculture, purchase agreements with restaurants and farmers' markets" (Palmer, 2018). As a result, fresh produce benefit consumers, the environment by way of increased urban ecosystem services and edible urbanists by completing the sustainability urban loop. In retrospect of building strong neighbourhoods, control processes of edible urbanism intertwine sharing and stewardship of open space and gentrification of urban compactness with the complete neutrality of EGI-friendly space (Russo and Cirella, 2018b).

Ecological urbanism, sustainable urbanism and landscape urbanism. As an overarching term, eco-urbanism refers to var-ious movements developed to, in addition to dealing with tradi-tional challenges of urbanisation, address the challenges posed by climate change and resource constrain (Sharifi, 2016). Miguel Ruano, architectural engineer who authored "Eco-Urbanism: Sustainable Human Settlements, 60 Case Studies", defined examples of best-practices as "the development of multi-dimensional sustainable human communities within harmo-nious and balanced built environments" (Ruano, 1998). Ecolo-gical urbanism looks at the city with multiple instruments and a worldview that is "fluid in scale with disciplinary focus" (Mos-tafavi and Doherty, 2010). Design requires an ecological con-nection simulative to a synthetic key in which urbanism is not in conflict with the environment. The ecological part of ecological urbanism modifies the urbanism in a particular way, requiring that ecology's characteristic scalar thinking addresses the inter-relationship between human culture and the biophysical envir-onment, specifically, between built culture, its makers and its inhabitants, and the physical city and its bio-environment (Hagan, 2014).

The eco-city, and related concepts and practices of sustainable urbanism, have since the early 2000s gained growing interna-tional popularity by entering into mainstream policy as a consequence of the forceful combination of global climatic

change and a rapidly urbanising world population (Joss, 2015). Sustainable urbanism grew out of three late twentieth century reform movements: "smart growth", "new urbanism" and "green buildings". Farr (2012) states "all three share an interest in comprehensive economic, social and environmental reform, […] and are essential stepping-stones to a cooperative framework" for urban sustainability. "Ecotown" concepts planned as new sustainable communities in the United Kingdom claim to achieve this, but paradoxically are planned on "greenfield" sites formerly used for agriculture and grazing (Knight and Riggs, 2010). Sustainability has been a component of urbanism for a long time, but in distinct respects and distinct phases of history (Roggema, 2016, 2017). Sustainable urbanism has evolved to suit design principles that are sustainability- and resilient city-friendly (Roggema, 2016). Sustainable urbanism looks at the city as an ecosystem, much like an urban metabolism defining city flows and interactions. Roggema (2017) states "the degree to which the system is able to deal with the flows, or networks of traffic, energy and materials, determines the sustainability of the system". In the concept called the strategy of the two networks, higher dynamic uses (i.e., traffic, industries and intensive forms of agriculture) connected to the transportation network while lower dynamic uses (i.e., nature, green, water and residential) link to the water network (Roggema, 2017; Tjallingii, 2015). Eco-city projects are site-specific and have their own requirements (e.g., "Zero-waste and zero-carbon emissions" project in Masdar City in Abu Dhabi in the United Arab Emirates (Reiche, 2010) or "Industrial symbiosis and recycling" project in Japan's eco-city initiatives) (Dong et al., 2016). No unanimous criteria have been framed. Internationally applied definitions of what currently constitutes an eco-city is standardised in sustainable urbanism terms; however, at a minimum it still promotes urban agriculture and local food networks (e.g., city food assets) (Dong et al., 2016; Roggema, 2017). We find an exemplar case of this in the Vancouver Greenest City 2020 Action Plan from British Columbia, Canada, in which the city has planned to increase city-wide and neighbourhood food assets (Fig. 2) by a minimum of 50 % over 2010 levels (Joss, 2015). Vancouver's food and sustainability-related policies align with the commitments of the Milan Urban Food Policy Pact in Italy, a set of commitments and action framework that emerged as a key legacy from the 2015 World Expo: Feeding the Planet, Energy for Life (Valley and Wittman, 2018).

A relating concept to ecological urbanism and sustainable urbanism, originating in the late 1990s out of landscape architecture, is landscape urbanism (Supplementary Note 3). It is primarily concerned with systems development and does not focus on the aesthetic qualities of space (Thompson, 2012). For example, Duany (2012) argues that "mediocre examples of landscape urbanism risk reintroducing the green buffer around modernist architecture" eliminates street-life several generations of urbanists struggled to reclaim (Dong et al., 2016). Landscape urbanism should then position itself as more cutting-edge to the broader community, and represent an ethos and attitude towards urban design rather than predominately a defined set of principles or strategies (Heins, 2015). Heins' (2015) viewpoint warrants merit since landscape urbanism is often cited as a postmodernist reaction to the shortcomings of new urbanism, as such it is a shift away from archetypal modern urban planning to a type of urbanism that anticipates change, open-endedness and negotiation. The paper by Prof Emily Talen, Professor of Urbanism at the University of Chicago, titled "Response to Matthew Heins" states the important interplay between two in which "new urbanism will absorb the best of landscape urbanism by intention, [while] landscape urbanism will absorb the best of new urbanism by default" (Dong et al., 2016).

Fig. 2 City-wide urban agriculture and EGI outlets found throughout Greater Vancouver, Canada. a Oak and 41st Community Garden, **b** John McBride Community Garden and **c** Burquitlam Community Garden Park (*Photographs taken by Giuseppe T. Cirella, September 2018*).

Food urbanism, agricultural urbanism, agrarian urbanism and CPUL. Food urbanism is a term that has been recently utilised by a number of different developments and project schemes theorising "space for food production, distribution and consumption share the ability to structure urban form in the contemporary city, and that by considering food in the broader sense, the health of both the city's residents and its physical environment can be improved" (Verzone, 2012). Food urbanism comprises of more than urban agriculture and notions of EGI, it interrelates food and the consumer with the prospect of creating a more complex interaction than those implied by the mere presence of agriculture as a "single, disconnected and peripheral land use in the broader urban metropolis" (Verzone, 2012). Agricultural urbanism, on the other hand, is an evolving movement centred on the concept of incorporating education and sustainable food systems with the design of the urban environment (Clarke, 2015). A food system involves infrastructure and feeding procedures for a population, from growing to processing, distribution to consumption and, lastly, recycling to growth. Agricultural urbanism has been described as the next big thing when it comes to new urbanism by a group of thought leaders and practitioners in the Provinces of British Columbia and Alberta, Canada (Philips, 2013). The core elements of agricultural urbanism include production, sales and education, the celebration of food and food security (Born, 2014). An agrarian urbanism concept interlinks food efficient designs to new urbanism principles, noted by American architect and founder of the Congress for New Urbanism, Andrés Duany (2012) in his book "Garden Cities: Theory and Practice of Agrarian Urbanism". Duany's design strategies and management practices detail the integration of food production into modern systems of development (DPZ, 2019; Ghosh, 2016)—"across the transect, from small-scale rural farming to urban container gardening" (Duany, 2012). Moreover, new urbanism as stated by Professor Emily Talen from the University of Chicago, stresses the importance of community formation and the design of cities, laying the foundation for "resident interaction and sense of community [in relation] to environmental factors" (Talen, 1999)

—a viewpoint that correlates with modern food urbanism's attempt to interlink food with community.

The use of the CPUL approach models a coherent strategy to interlink productive landscapes into cityscape, thereby creating a "new sustainable urban infrastructure and supporting a re-definition of open urban space usages" (Bohn and Viljoen, 2011). Main features of CPUL space include urban agriculture, outdoor spaces for people (e.g., leisure and commercial), natural habitats, ecological corridors and circulation routes for non-vehicular traffic (Bohn and Viljoen, 2011) (Supplementary Note 4). CPUL city and food urbanism concepts aim to offer design solutions for knitting agriculture into the urban fabric (Vijoen et al., 2015).

Nourishing urbanism and biophilic urbanism. Nourishing urbanism aims at shifting the urban and non-urban paradigm—in relation to energy, water, soil loss and nutrient depletion and food—toward a framework that unites bio-regional and local scales. This unifying concept demands land use policy, planning and design change, as well as a "symbiosis paradigm shift from urban dominance over the non-urban" (Knight and Riggs, 2010). The notion of a basic biophilic need of connecting with the natural environment links human beings with energy, water, soil and urban agriculture in a "nourishing" fashion. Nourishing urbanism influences urban governance by "positively veering its dominant role of reinforcing and strengthening non-urban environments" (Knight and Riggs, 2010). In professional terms, Lewis Knight and William Riggs, both academic heavyweights based out of UC Berkeley, elucidate nourishing urbanism as "a new normative framework that turns environmental advocacy into activism" (Knight and Riggs, 2010). Expanding upon this, it aims directly at its overseers' ability to conduct and live by example. It stressed professionals must practice, live, work, play, eat, garden and green their immediate environments in an exemplary manner for the community at large. Nourishing urbanism is an education-oriented practice that reconnects urban and non-urban environments through a strengthened urbanism

by welcoming healthy environments fuelled by the mobility of goods, services and agriculture. It ensures a generational exchange of knowledge and stresses the intrinsic desire to seek connections with nature and best understand that relationship. In summary, nourishing urbanism informs urbanites of where and how (1) energy is produced, (2) water is utilised, (3) soil loss and nutrient depletion occurs and (4) food is grown.

Closely related, biophilic urbanism builds on theoretical concepts of an innate affiliation with nature to propose design elements and planning strategies that enhance holistic-oriented health and wellbeing from the urban environment (Reeve et al., 2015). Growing of food in cities is an important biophilic design strategy, as it offers the chance for urbanities to connect with soil and plants and to produce more locally grown food (Beatley, 2011). Biophilic urbanism can achieve significant water conservation and, through the protection of peri-urban farms and agriculture and by promoting urban agriculture, can help to ensure the food security of a city (Beatley and Newman, 2013). Many biophilic partner cities, and other interested cities, are studying and implementing urban agricultural-related projects (Beatley, 2013). Projects range from the urban farm on top of the KTPH hospital in Singapore and the community gardens in Vitoria-Gasteiz's green ring in Spain, to San Francisco's abundant gardening and food production spaces, both temporary (e.g., Hays Valley Farm) and more permanent (e.g., Tenderloin People's Garden) (Beatley, 2013). This dichotomy between the urban and non-urban spans the desire to design nature-based solutions within the built environment by addressing contemporary urban settings and providing for meaningful experiences for urbanites alike. The application of biophilic design and urbanism require a deeper understanding of how contact with nature functions as the basis for a healthy, productive and well-off urban experience (Beatley, 2013). In consequence, philosophical and practical inferences of biophilic urbanism has been shown to be exceptionally useful to practitioners of the built environment.

Unsustainable urban agriculture practices

Edible urbanism 5.0 reflects the evolutionary development of the varying concepts of urbanism that have become commonplace for the production of food in cities. Some of these concepts entail industrial intensive farming (e.g., vertical farming) as a sustainable practice to address the issue of food security (Al-Kodmany, 2018). Controversially, new farming architecture has been ever-increasing since the 1990s, in the wake of the smart cities movement, in which for the better part of three decades urban planning designs have evolved in close proximity and sometimes within urban centres (e.g., cultivating plants or breeding animals within tall greenhouse buildings and vertically inclined surfaces) (Mancebo, 2016). However, a number of issues inherent to vertical farming is evident (Hamm, 2009; Mancebo, 2016). First, if a building is largely fenestrated, crops still require soil and additional sunlight to survive. When sunlight is replaced by light-emitting diode (LED) lights, it can pose high energy costs (Mancebo, 2016), for example C.S. Mott Professor of Sustainable Agriculture Michael W. Hamm from Michigan State University and Director of the MSU Centre for Regional Food Systems calculated the cost of the light energy to grow wheat under indoor conditions for New York City inhabitants, assuming use of efficient red-blue LEDs and US$ 0.10 per kilowatt-hour the electricity for this production would cost about US$ 327 per square metre per year or about 100 times the wholesale value (Hamm, 2009). Second, controlling humidity and air circulation, and evacuating the heat released by LEDs also poses high energy costs. Third, fertilisers will always be a necessary part of the agriculture, as would pesticides due the mildew and other pests found in

greenhouses (Mancebo, 2016). This preoccupation with new urban agriculture stresses an opening up of unused sections of, or to completely dedicate an entire, high-rise building to "intensive, city green agriculture" (Mancebo, 2018). Accordingly, concrete and glass towers may become suitable places where citizenry becomes susceptible to a "greening" urban architecture (Mancebo, 2018). Theorising a future where ground level floors could, conventionally, become urban farms and locally grown would be literally at a person's doorstep, possible causes for concern (Russo and Cirella, 2018b) include the "dissemination of pesticides and fertilisers, which would have a negative impact on health and on the biodiversity in the city" (Mancebo, 2018).

An important statement by Domenic Vitiello, Associate Professor and Assistant Chair of City Planning and Urban Studies at the University of Pennsylvania, is that industrial-level agriculture's dependence on fossil fuels is unsustainable (Vitiello, 2008). It can, however, be stated that new urbanists are in favour of industrialised agriculture since there is a belief that the transition from primitive agricultural-based system to advanced industrial-based society has the potential to generate mass production, most importantly food (Azadi et al., 2012). New urbanists argue that "land conversion is a logical consequence of urban sprawl and the decline of agricultural production can be compensated by using modern technologies and capital-intensive production techniques in the food production chain" (Azadi et al., 2012). On the other hand, new urbanism approaches such as Duany's agrarian urbanism demonstrates that it is possible to protect land, natural areas and agrarian lifestyles of a community, initiate local economic growth and accommodate urban growth sustainably using appropriate design and planning in peri-urban areas (DPZ, 2019; Ghosh, 2016).

Research by Daina Romeo and her colleagues from the Department of Environmental Science at Aarhus University in Roskilde, Denmark examined vertical high-yield hydroponic crofts located in the urban area of Lyon, France from a life-cycle perspective (Romeo et al., 2018). Their results indicate that the hydroponic farms performed better than cultivations in heated greenhouses, and similarly to conventional open field farms. Moreover, the source of the electricity input was a determinant factor that, if carbon neutral (e.g., wind energy) could be optimised, it was found that vertical hydroponic production outperformed the two conventional types of agriculture (Romeo et al., 2018). More research to evaluate the environmental impacts, crop choice, economics and energy requirements of vertical farming in cities is needed (Beacham et al., 2019).

Edible cities

Many cities worldwide have modified their planning and zoning codes to permit urban agriculture (Beatley and Newman, 2013), with the support of food-oriented movements, initiatives, and projects (e.g., Green Guerrilla, City Farms and Community Gardens, London 2012 Capital Growth) (Nadal et al., 2015) we are moving toward a renewed conservation and recovering of old varieties (Fig. 3). New concepts of food-oriented urbanism have given birth to the development of edible cities. Three prominent examples are discussed.

First, in the city of Andernach, Germany, labelled an edible city, residents grow edible plants in public green spaces. This practice, conducted for a number of reasons, include: (1) to raise awareness for local food where people can harvest for free, (2) to help people eat healthily, (3) to integrate different sociocultural groups into using and managing the urban food system and (4) to inspire public debate about how to develop urban space (Fischer et al., 2018). Second, the city of Todmorden in West Yorkshire, United Kingdom, in which since 2007 has been the focal point of

Fig. 3 International example of urban agriculture. a Calthorpe Project Community Garden, London, United Kingdom. The Calthorpe inner city community garden and centre exists to improve the physical and emotional wellbeing of those who live, work or study in Camden, London and surrounding areas, **b** guerrilla gardening in Berlin, Germany, **c** Roman ancient grape varieties grown in Pompeii Archaeological Park, Italy and (**d**) Hortus Urbis is the first edible garden with solely ancient Roman plants, Rome, Italy (*Photographs taken by Alessio Russo, June 2018*).

the pioneering social movement called Incredible Edible (IE), which uses locally grown food as a way to enrich communities. The IE model, as developed and applied in Todmorden, is based around a conceptual metaphor of three "spinning plates" (Paull, 2011; Warhurst and Dobson, 2014). Each plate represents one of the three core activities of IE volunteers: (1) community: growing food in public spaces within the community that is free for people to take, (2) business: supporting local food-related enterprises and (3) learning: providing training and passing on skills. The use of "propaganda gardening" to grow food in public spaces helped to improve the appearance of the town, at the same time creating awareness, catalysing conversations within the community and encouraging people to re-evaluate their relationship to their local environment (Morley et al., 2017). Third, in Taipei, a vibrant urban agriculture movement has been unleashed named the Garden City Initiative, supporting the establishment of urban gardens (i.e., community gardens, rooftop gardens and school gardens) for food security and climate adaptation (Hou, 2018). The experience of Taipei's initiative raises a series of important questions concerning the establishment and management of an urban gardening programme in a large metropolitan area where no such effort has existed previously (Hou, 2018). Edible city solutions are growing and show a strong potential for participatory social cohesion, growth that has demonstrated emancipatory citizen engagement and effective inclusive urban regeneration (Fischer et al., 2019; Kohler et al., 2019; Kowalski and Conway, 2018; Landor-Yamagata et al., 2018; Stoltz and Schaffer, 2018; Talen, 1999).

To implement edible urbanism movements there is a need for an integrated urban approach of land use planning and territorial governance in the direction of multifunctional land use and ecosystem services in cities, which bridges interests and fosters cooperation between different actors (i.e., city administration, farmers, gardeners in urban gardening initiatives and traditional allotment gardeners) (Jahrl and Schmid, 2017). As such, EGI-

based governance and policies become an important research agenda for the harmonious development of food security, resilience and social inclusion. Externalities of developing an edible city, in terms of this three-pillar approach, is balanced applicability of urbanism with an effective EGI governance mode based on sustainable development planning. Synergy between human and nature, based in biophilic urbanism, presents a framework for an EGI-based theory of innovation in which the development of governance guidelines corresponds with a city's carrying capacity, its application of nature-based solutions and adeptness to urban food systems development. Edible urbanism 5.0 incorporates site-specific, best-practices with the profound adaptation of integrating EGI-based governance with food modernisation techniques.

Future of edible urbanism
For over a century planners and visionaries have developed planned neighbourhoods as remedies for problems caused by unregulated urbanisation (Sharifi, 2016). However, twenty-first century urbanists been paid little attention to the alimentary regime of cities (Rhys-Taylor, 2017). For example, urban plans, such as Le Corbusier's Chandigarh or Lucio Costa's Brazilia, agriculture was banished from these large cities (Nadal et al., 2015). In this paper, we have examined how urbanists have developed numerous approaches to linking nature, ecology, agriculture and food with the city. Modern urbanites disconnected from nature and the elderly are often exposed to only a cementified environment that urbanists can cater too. The edible urbanism concept implies both sustainability and resilience. Nicholas Clinton and his scientific group based out of Beijing, China and Temple, AZ, USA, estimated the value of selected ecosystem benefits of urban agriculture (i.e., food production, nitrogen fixation, energy savings, pollination, climate regulation, soil formation and biological control of pests) could be worth as

much as US\$ 80–160 billion annually in a scenario of intense urban agriculture implementation at global scale (Clinton et al., 2018). As EGI and urban agriculture contribute to the intensive use of water (Dalla Marta et al., 2019), urban planners should take into account climate change and future water scarcity. Even the water required to produce, for example, 1 kg of tomatoes can vary from 50 l to 100 l depending on the climatic conditions (De Bon et al., 2010). Thus, as domestic and industrial demands for freshwater resources increase, it becomes unreasonable to consider irrigating crops with domestic and potable water (De Bon et al., 2010). Furthermore, urban agriculture and EGI being implemented in urban areas, are rooted in some of the most polluted environments on Earth, and caution needs to be taken to prevent pollutants from entering the food chains (Ferreira et al., 2018; Russo et al., 2017). As an aftereffect, this would raise public awareness, reduce the public health hazard and safeguard the environment, especially our urban soils, from future pollution, erosion and neglect (Brown and Jameton, 2000). However, this concept faces a number of challenges, such as pressure on open space and farmland, barriers to cooperation with more traditional farmers, a lack of entrepreneurial skills, achieving and maintaining profitability, lack of finance, sources of pollution arising from industrial activity, and soil contamination (McEldowney, 2017). Growing greener cities with agriculture needs governmental support, from national to local levels (FAO, 2014). The promotion of the multiple functions of EGI is a major challenge for the future (De Bon et al., 2010). Accommodating urban gardening and food production in cities requires negotiating between various interests wielding differential levels of power to defend their claims to urban space (Barthel et al., 2015). For urban planning and decision-making, future research is the edifice of edible urbanism 5.0 in which validation of design-based critical analysis includes aspects that influence food (e.g., urban scale, density, building typologies and urban spatial transformation) for the design of EGI. For example, high-rise buildings could affect turbulent air flows and dispersion of pollutants creating a barrier between EGI and pollution sources (Aristodemou et al., 2018). However, tall-buildings cast large shadows and blocking sunlight that can have negative effects on plant growth and crop yield (Ali and Al-Kodmany, 2012). Edible forest gardens need to identify species and design combinates that work in different types of sites and evaluate ecosystem services provided by different designs (Björklund et al., 2019). Future research should also analyse case studies on how design and edible urbanism approaches can integrate three main principles of sustainability by fulfilling food security, resilience and social inclusion. The profound and deepest desire of using science for the good of humankind, meeting its daily needs, is a branch to healthier, happier people. As people continue to become urbanites, urban communities that foster EGI and food systems integration will better meet these needs for the next food revolution.

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The authors declare no competing interests.

Additional information

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Correspondence and requests for materials should be addressed to G.T.C.

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