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Sustainability Assessment of Urban Agriculture

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17.1 Agriculture in Urban Systems

Urban agriculture has attracted the attention of academics, policy-makers, and practitioners alike as a potential measure to support the food needs of growing urban populations and contribute to addressing some of the negative environmental and economic effects of urbanization (De Bon et al., 2010; Mougeot, 2005; Orsini et al., 2013; van Veenhuizen, 2006). Urban agriculture can be defined as "[a]gricultural production (crops and livestock) in urban and peri-urban areas for food and other uses, the related transport, processing and marketing of the agricultural produce and non-agricultural services provided by the urban farmers (water storage, agro-tourism, urban greening and landscape management, among others)" (de Zeeuw, 2004, p. 2). Urban agriculture may occur within the city boundary (intra-urban agriculture) or in the spaces immediately surrounding it (peri-urban agriculture). It is also highly diverse, and can appear in many different forms, from community gardens, home gardens, rooftop gardens, urban farms, guerrilla gardens, and backyard gardening to livestock farming, and aquaponics systems (de Zeeuw, 2004; Lin et al., 2015).

Urban agriculture can make positive contributions to food security and nutrition (Eigenbrod & Gruda, 2015; FAO, 2007; Orsini et al., 2013; Poulsen et al., 2015; Zezza & Tasciotti, 2010). However, land availability in and around cities is often a constraint (Badami & Ramankutty, 2015) and the actual food produced may be minimal in some contexts (Warren et al., 2015; Zezza & Tasciotti, 2010). Nevertheless, between 100 and 800 million people worldwide are estimated to earn part of their income directly from urban farming, or to be actively engaged in urban agriculture for subsistence including from the exchange or sale of surpluses (FAO, 1996; FAO, 1999). In cities in the Global South, up to 32 percent of dwellers can be full- or part-time farmers (de Zeeuw & Dubbeling, 2009; the percentage can be higher in certain contexts – see Drechsel & Keraita (2014) who estimated 60 percent of dwellers in Accra, Ghana). Urban agriculture also contributes to economic development. Various studies have shown that urban farmers in the Global South earn incomes significantly higher than the minimum subsistence income, while urban farms also generate additional income from related activities such as agro-tourism (De Bon et al., 2010; de Zeeuw & Dubbeling, 2009; FAO, 2007; Orsini et al., 2013; Poulsen et al., 2015; Zezza & Tasciotti, 2010). Urban agriculture initiatives have often been initiated by local authorities or non-governmental organizations (NGOs) with the aim of

fostering social and gender integration, and poverty reduction. Moreover, urban agriculture can promote community-building, civic engagement, empowerment of youth and minorities, physical and psychological relaxation, environmental education, and the provision of care for people with psychological disorders (Poulsen, 2017; van Veenhuizen, 2006). Furthermore, food production in an urban context can strengthen the symbolic connection between people and their food culture (Sahakian et al., 2016).

Finally, urban agriculture can contribute to urban environmental management. On the one hand, agricultural production can reuse composted urban organic waste. In addition, it can have a positive impact upon the greening of the city, for example through the creation of green belts, the improvement of the urban microclimate (wind breaks, dust reduction, shade, sequestration of CO_2 and other pollutants), the conservation of soil, water, biodiversity, and the cultural landscape, and the provision of ecosystem services (pollination, pest control, and climate resilience) (Drechsel & Keraita, 2014; Galluzzi et al., 2010; Lin et al., 2015; Pearson et al., 2010). Notably, due to the proximity of production to consumers, urban agriculture may entail a low ecological footprint and a reduction of "food miles" and the associated carbon footprint (but see Goldstein et al., 2017).

On the other hand, urban agriculture has also been associated with health and environmental risks. First, it can be impacted by contaminants emitted by other urban activities (e.g., uptake of heavy metals in soils, or air and water pollution). Second, urban agriculture, especially when not conducted according to best practices, can contaminate the urban environment (e.g., agrochemical residues or excess nitrate in water courses and water supplies) (Rabinovitch & Schmetzer, 1997). Certain diseases, such as bovine tuberculosis, pork and beef tapeworm, trichinosis, anthrax, salmonella, and campylobacter, can also be transmitted from domestic animals to people, with the risk being high in urban contexts in which agriculture is contiguous to densely populated residential areas. Finally, urban agriculture is also associated with occupational health risks (e.g., handling of agrochemicals), and with possible conflicts with non-farming neighbors who may raise concerns about dust, smell, and noise created by the urban farms (de Zeeuw, 2004).

Urban agriculture is increasingly seen as a viable policy option to increase urban food security and sustainability. Governance is central to ensuring that positive nutritional, economic, social, and environmental outcomes are maximized, while minimizing or avoiding potentially negative impacts. Considerable advances have been made at the research-policy interface to derive lessons, best practices, and guidelines for the implementation of urban agriculture initiatives (de Zeeuw & Dubbeling, 2009; van Veenhuizen, 2006). However, urban agriculture has traditionally raised governance issues that remain largely unresolved. First, urban agriculture's sheer diversity implies that no one-size-fits-all policy is effective for governing it. Second, as borderlands, peri-urban spaces are economically multifunctional, socially diverse, and ecologically complex, but theories of the persistence of agriculture in and around cities have had difficulties in grappling with the hybrid nature of these spaces (Lerner & Eakin, 2011; Madaleno & Gurovich, 2004; Mendez et al., 2005; Pérez-Martinez, 2016). Third, competing policy narratives often misinterpret urban agriculture – for example, as a purely male or female activity (Mougeot, 2005). Similarly, urban

agriculture has been leveraged differently by institutional actors (e.g., local authorities, international organizations), which have privileged particular discursive framings (e.g., the socially inclusive city, the environmental/sustainable city, economic development) to pursue different policy objectives (van Veenhuizen, 2006). Fourth, local planning processes have often failed to integrate different themes (i.e., health, environment, social, economy), or to institutionalize the incorporation of different types of knowledge in the governance of urban and peri-urban spaces (Marshall et al., 2017). Therefore, governance approaches have usually failed to create institutional, policy, and planning arrangements that are conducive to sustainable urban agriculture (de Zeeuw & Dubbeling, 2009; Drechsel et al., 2006; Lerner et al., 2013; Olsson et al., 2016; Pearson et al., 2010).

Sustainability assessment can play an important role as part of a broader governance strategy to support sustainable urban agriculture (de Zeeuw, 2004; Lang, 2014; Pearson et al., 2010; Quon, 1999). As noted by de Zeeuw and Dubbeling, an "urban food policy should be based on a systematic multi-actor assessment of the actual food system in the metropolitan or city region and an integrated and comprehensive plan on how to strengthen the urban food system, looking into regional/local food production and other supply chains, distribution (effective, equitable), health, economic and environmental and resilience aspects" (2009, p. 32). Indicators for sustainability assessment, if appropriately embedded in local governance systems, can usefully contribute to policy decisions and be meaningful to urban planners and local community gardeners (Beilin & Hunter, 2011). Yet Lang (2014) warns against the risk of an excessive focus on indicators per se, and further calls for better understanding of how urban sustainability initiatives might work with, but also move beyond, indicators, which may offer guidance in moving toward wider visions of sustainable urban life.

This chapter engages with the existing literature on urban agriculture and with concrete case studies to examine current challenges and ways forward for the sustainability assessment of urban agriculture. The chapter identifies current conceptualizations of urban agriculture, and sustainability assessment methods, and discusses them in the light of normative, systemic, and procedural dimensions of sustainability assessment (Binder et al., 2010). The diversity of urban agriculture and its presence in very different urban contexts worldwide, represent challenges for sustainability assessment. It increases the need to carefully select distinct sustainability assessment methods that may be appropriate for different contexts and purposes (Binder et al., 2010; Gasparatos, 2012), and to practice caution and self-criticism in adapting methods developed elsewhere to new contexts (Barrett et al., 2017). Specifically, this chapter asks the following questions:

- How can urban agriculture be conceptualized? In particular, are there important conceptual differences between urban agriculture in the Global North and South, or between distinct forms of urban agriculture?
- How can the sustainability of urban agriculture be assessed? What methodological differences, if any, should be taken into consideration in assessing different forms of urban agriculture in distinct urban contexts?

- What are the current challenges and what are the opportunities for improving the sustainability assessment of urban agriculture?

17.2 Conceptualizing Agriculture in Urban Systems

Scholars have approached the diversity of urban agriculture from a range of perspectives (Table 17.1). For example, the extension of cultivated land, and the degree of access to irrigation resources and infrastructure can vary substantially across locations (Thebo et al.,

Table 17.1 *Sources of diversity in framing urban agriculture. An asterisk denotes the sources that are particularly relevant in urban as opposed to rural agriculture.*

Sources of diversity	Descriptor
Goal	
Purpose	Subsistence, commercial, multifunctional
Main function	Food production, ecotourism, educational services, care services
General geographical characteristics	
*Location	Intra-urban/peri-urban; ground/rooftop
Land extension	Small to large farms
*Resource-use profile	Integration in the built environment, energy for space conditioning (light and temperature)
Infrastructure	Access to irrigation, transport, electricity, etc.
Farming characteristics	
Agricultural system	Crop, livestock, mixed
Produce	Type of crop or animal product
Management	Individual/family/collective
Institutional/social characteristics	
Formality	Formal/informal
Farming philosophy	Conventional or alternative (e.g., organic, permaculture)
*Values	Reconnect with nature, poverty alleviation, civic protest or political activism, food justice
*Social groups involved	Male/female/mixed, urban poor/affluent/mixed, local residents/immigrants/mixed
*Institutional integration	Degree and forms of collective association (e.g., cooperatives)

2014). Similarly, urban agriculture is characterized by differing levels of integration into formal markets and institutions such as farmer and producer organizations, or planning or consultative committees (FAO, 2007; Schmidt et al., 2015). The Food and Agriculture Organization of the United Nations (FAO), proposed a tripartite typology – multifunctional, commercial, and subsistence agriculture – based on the purpose and livelihood structure of urban farmers (van Veenhuizen, 2006). These types of urban agriculture may also be related to different motivations for engaging in food production (e.g., saving on food expenditures or making a profit from the sale of produce) and to different contextual conditions (e.g., access to land, personal skills). Goldstein et al. (2016a), instead, used a taxonomy based on resource-use profiles. They identified two variables, namely building integration (physical embedding of urban agriculture within the built environment) and space conditioning (degree of interaction between urban agriculture and the ambient environment), and on this basis, developed a matrix of four urban agriculture types. Mendez et al. (2005) proposed an urban agriculture typology based on the motivation for its emergence: (i) economic necessity), (ii) absorption in the expanding urban system, (iii) external or internal institutional intervention, (iv) exploitation of available resources (e.g., space), or (v) expression of rural antecedents.

Important differences can also be noted in the way urban agriculture has been framed in debates and political action in different contexts (Table 17.1). By and large, urban agriculture in the Global North has often been associated with progressive movements promoting sustainable lifestyles and reconnection with nature, in the context of civic and political struggles, as in the food justice and food sovereignty movements (Goodman et al., 2012; McClintock, 2014), or in relation to educational or social integration programs (Saldivar-Tanaka & Krasny, 2004; Savoie-Roskos et al., 2017; Shinew et al., 2004). Thus, in the Global North urban agriculture has mostly been a terrain for political and social change, while the potential for actual food production and income generation has been marginal (perhaps with the exception of some "food deserts") (Hashim, 2015; Tornaghi, 2014). In the Global South, in contrast, urban agriculture has often been framed in terms of development, which brings to the forefront the potential of urban agriculture to favor social integration, providing employment and contributing to poverty reduction, and to produce food both for subsistence and for the market (Sahakian et al., 2016). Agriculture in cities in the Global South has also often been an arena for social struggles and the empowerment of marginal groups, as in the agroecology and food sovereignty movements. It can further be argued that many of those struggles have come about as part of counter-development movements, and as such they have been influenced, if only as counterpoints, by developmentalist discourses (Chappell et al., 2013). Such framing does not fully capture other trends that may relate to urban agriculture, such as changing diets and practices among the urban middle classes, which impact the demand for particular types of food (dairy, meat), food waste, and food circulation associated with changing food habits (e.g., eating out) (Sahakian et al., 2016). Understanding food consumption practices in urban spaces in the Global North and South is a growing area of study, linking the sociology of consumption with urban and environmental studies (see also Box 17.1).

Box 17.1 Perceptions of "local and seasonal" food among urban consumers in Switzerland

Households have an important role to play in transitions towards "healthy and sustainable food," which relates to how people represent notions of health and sustainability in their day-to-day diets. A recent study in Switzerland set out to uncover "food prescriptions," or all of the diverse guidelines around what and how one should eat (Plessz et al., 2016). Through qualitative research, involving discourse analysis, observations, in-depth interviews, and focus groups, the more dominant prescriptions related to healthy and sustainable diets were identified, revealing overlaps and tensions between them (Godin & Sahakian, 2018). The main finding was that health is a more prominent concern than environmental responsibility. All of the prescriptions relate to healthy people, while concerns about a healthy planet are much less dominant. The notion of a "balanced meal" is the more prominent prescription, along with the idea that food and eating should be "pleasurable." Increasingly, "local and seasonal" food production is normalized as contributing to "healthy and sustainable" diets, thus prompting increased interest in alternative food networks, including urban agriculture. Guidelines that encourage eating "local and seasonal" products overlap with "organic and natural" food consumption, while prescriptions to "eat less meat of higher quality" are in tension with prescriptions around "vegetarian and vegan diets." These prescriptions are set forth by different types of actors, from the Swiss nutritional society to retailers or citizen associations, but also friends and family. The media represent an important site for prescriptions to be vocalized, be it in the general press or in the blogosphere. Prescriptions exist at the level of discourse and representations, but also play out in practice; in this respect, they can either be a resource for or an obstacle to healthy and sustainable eating habits. For the latter, the sheer amount of prescriptions and tensions between them seem to suggest that people are burdened by making the right choice in relation to health and sustainability: "Too much choice kills choice," as one interviewee declared. Placing the responsibility for transitioning to healthy and sustainable diets on consumers alone disregards the different ways food consumption plays out in practice, and changing this would involve tackling three main elements: the social norms and prescriptions around food; people's skills and competencies when it comes to preparing meals or urban gardening; and the availability of and access to certain products, or retail or gardening spaces. Guidelines or prescriptions are therefore not enough, in and of themselves, to shift people's diets. Other factors that must be taken into account include time availability, the links between mobility and food preparation in urban centers, and the social relationships built around food and eating.

17.3 Approaches and Methods for Assessing the Sustainability of Agriculture in Urban Systems

The number of methods specifically developed to assess the sustainability of urban agriculture is limited. Furthermore, the "literature reveals various approaches to and indicators for measuring the sustainability of [urban agriculture], but to date, few systematic attempts have been made through monitoring its presence and impacts over a longer period of time in a given city or cities" (FAO, 2007, p. 70).

Box 17.2 **A geographic information system to estimate the potential of urban agriculture**

The development of urban agriculture requires suitable surfaces in cities. Thereby, conflicting interests play a role when deciding upon the use of a specific piece of land. A geographic information system (GIS)-based land inventory and yield estimates can support policy-makers in the development of urban agriculture zones and in weighing the benefits of using land for agriculture against other possible uses. Baker (2012), Saha and Eckelmann (2017), and Zundritsch (2018) propose a methodology using GIS to develop an inventory of feasible urban agriculture sites.

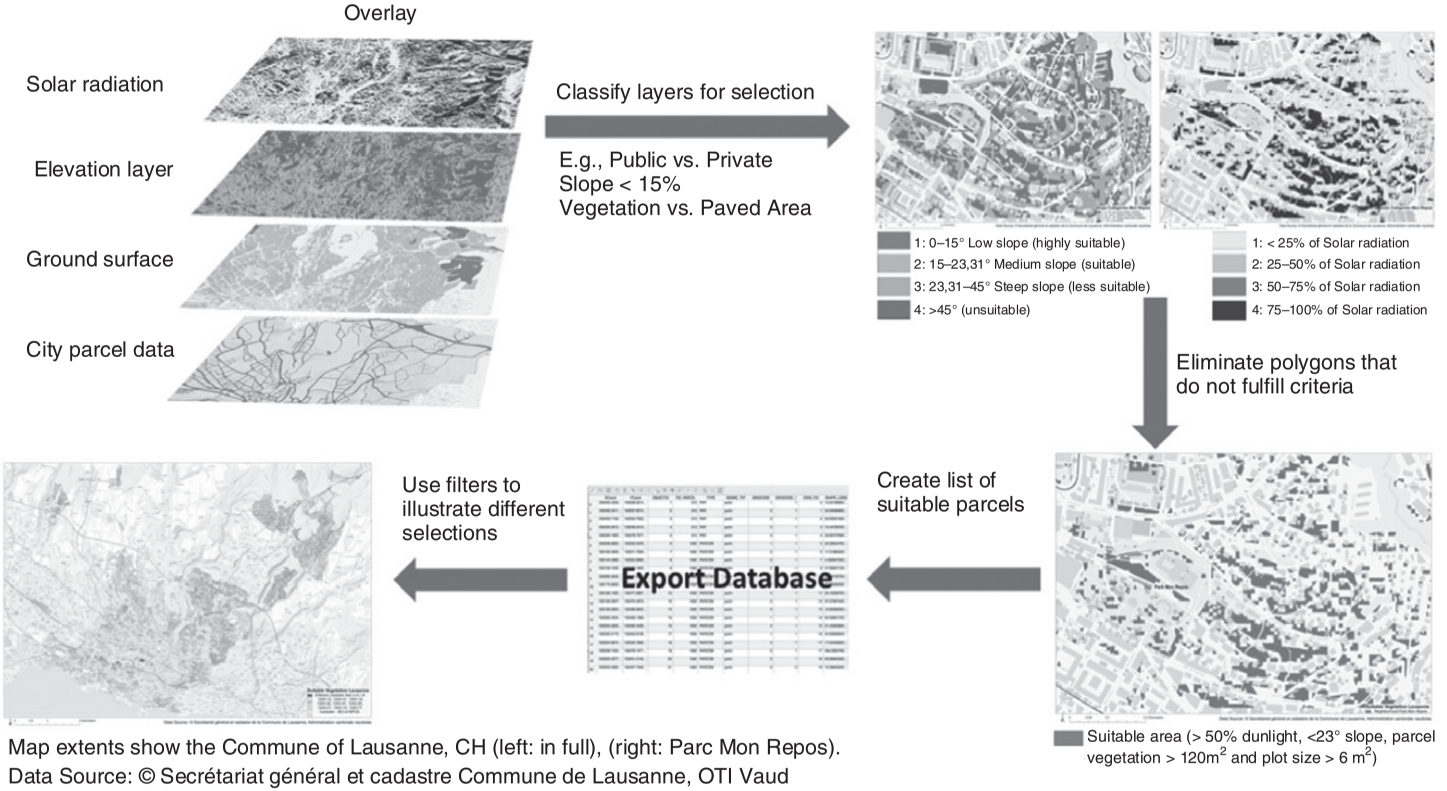
The criteria for determining suitable areas for urban gardening depend on whether we are dealing with ground level or rooftop urban agriculture. On the ground, high-resolution maps of green spaces are needed, which might be available from city cadastre data. Alternatively, a detailed layer of vegetation can be derived from the intensity of reflection of a laser beam that is used in LIDAR surveying technology (Teo & Wu, 2017). For rooftop mapping, layers of building footprints and elevation models are required. In addition, economic factors such as ownership of parcels (public or private) and land use determine whether the area can be developed. Including vacancy in GIS models is difficult, due to its dynamic nature and the fact that there are few reliable or accessible data sources. Tax data or real estate assessors' databases may be used if available (Baker, 2012).

For estimating the potential harvest, environmental factors such as the slope of a site, light exposure, site pollution, soil quality, and water access have to be considered. Quality limits and suitability classes vary depending on a site's location and the type of urban gardening. Sizes of plots and their proximity and accessibility to interested citizens are two additional factors influencing behavior and harvest.

The Swiss city of Lausanne has about 150,000 inhabitants and an area of 46.22 km². A spatial analysis for the geographic data layers of public and private ownership, vegetation type, area solar radiation, and slope was performed for different combinations of the criteria and for various minimum plot sizes. The potentially suitable ground area was found to be between 5 km^2 and 10.16 km^2, representing 11 percent and 22 percent respectively of the total land area in Lausanne (Zundritsch, 2018). This area is split almost evenly between public and private parcels. However, public parcels are often more exposed to sunlight and less sloped than private parcels. The resulting potential corresponds to research in US cities where a range of 2.3–7.8 percent of total municipal land areas was found suitable according to the same criteria and additionally including whether the land was currently vacant (Grewal & Grewal, 2012; McClintock et al., 2013).

Yet, the range of existing sustainability assessment methods is relatively large. While indicator-based assessment methods are very common, the sustainability of urban agriculture has been assessed also via methods relying, for example, on geographic information systems (Box 17.2; see also Ghosh (2014) on the use of GIS to estimate available land for agriculture), and life-cycle analysis (Box 17.3).

Indicators have often been used to assess the sustainability of urban agriculture. The FAO (2007) identified commonly addressed sustainability criteria, which included productivity, land security, protection of environment and people, economic viability, social and political



Map extents show the Commune of Lausanne, CH (left: in full), (right: Parc Mon Repos).
Data Source: © Secrétariat général et cadastre Commune de Lausanne, OTI Vaud

Figure 1 (Box 17.2) Geographic information systems methodology (inspired by Ringenbach, Valcourt and Wang, 2013)

Box 17.3 **Life-cycle assessment of urban agriculture**

Some sustainability assessment methods based on life-cycle assessment (LCA) have been proposed as alternatives to indicators. LCA quantifies the environmental impacts associated with a product, service, or activity throughout its life cycle. Goldstein et al. (2016b) performed an LCA to assess the environmental performance of lettuce and tomato production in urban farms in Boston, USA. Environmental performance was defined in this study as a composite measure of (i) supply-chain efficiency (reduced distance from farm to consumer attenuating "food miles" and carbon footprint); (ii) urban symbiosis (interactions with a city's material and energy fluxes, reduction of a farm's operational inputs, absorption of urban waste flows such as food waste, lowering building energy demand, and other local environmental benefits such as tempering storm water runoff); (iii) ex-situ environmental benefits (reductions in agricultural land occupation, carbon sequestration). Goldstein et al. (2016b) adopt a cradle-to-shelf approach that includes cultivation, harvesting, and distribution of food to market, but not post-purchase transport and preparation.

Similarly, Kulak et al. (2013) used LCA to quantify the potential savings of food-related GHG emissions that may be achieved with the establishment of an urban community farm in London, UK. Their analysis assumed that fruit and vegetables produced by the community farm would substitute for the same commodities available at the local supermarket and supplied through the conventional food chain. Data for development of the LCA inventory, as well as future scenarios for the community farm, were collected through interviews and field visits.

Sustainability assessment methods based on LCA may hold potential for providing a detailed analysis of environmental sustainability. However, they tend to be limited to the environmental dimension of sustainability, and as shown by these examples, require numerous assumptions, as do indicator-based methods. Furthermore, to the authors' knowledge and in contrast to indicator-based methods, to date LCA-based methods have not been used in actual governance of urban food systems.

acceptability, and ability to form cooperatives (FAO, 2007). A higher number of studies, though, appear to have specifically addressed the profitability of urban agriculture (FAO, 2007). Based on existing experiences of sustainability assessment, the FAO (2007, p. 27) proposed that the "sustainability of [urban agriculture] basically implies its ability to continue in the future and operate at the current or increased levels. In order to be sustainable, [urban agriculture] should be profitable and economically viable, environmentally sound, socially just and culturally acceptable." While the FAO does not propose a specific assessment method, it puts forward a general indicator list comprising 25 economic, environmental, and social indicators, variably measured at household, city, or macro level (FAO, 2007).

Soler Montiel and Rivera-Ferre (2010; see also Ortega-Cerdá & Rivera-Ferre, 2010) depart from a notion of urban agriculture sustainability that is rooted in an agroecological and food sovereignty perspective. In this view, urban agriculture conducted according to agroecological and food-sovereignty principles can be a tool for urban sustainability with deep implications not only at the ecological level, but also at the social level. According to this perspective, urban farms can help reorient current urban development models from an

individualist model to a more equitable one, in which citizens can play a more active, participatory role in the definition of public policies. Based on these premises, Soler Montiel and Rivera-Ferre (2010) identify five areas for assessment: (i) access to resources, (ii) production model, (iii) transformation and commercialization, (iv) food consumption and the right to nutritious food, (v) agricultural policies and civil society organization (Ortega-Cerdá & Rivera-Ferre, 2010). While Soler Montiel and Rivera-Ferre (2010) do not identify an indicator list, they specify the criteria for the selection and operationalization of their assessment areas, which include their simplicity and low measurement cost, their participatory nature (i.e., whether stakeholders participate in the process of knowledge-generation), and their flexibility (i.e., their applicability to a wide range of regions and contexts).

Participation processes are central in other indicator-based assessment methods. For example, the Farming Concrete Data Collection Toolkit (Farming Concrete, 2015) is a protocol developed by the community-based research project Farming Concrete in New York, USA. This tool is intended to support local communities to measure the outcomes and impacts of community gardens and urban farms. The toolkit enables measurement of food production (crop and harvest count), environmental data (landfill waste diversion, compost production, rainwater harvesting), social data (participation, skills and knowledge creation, outreach), health data (attitude change, emotions, healthy eating, aesthetics of the garden), and economic data (market sales, donations of food). The toolkit has an explicit aim of enabling communities to measure the positive impacts of their urban agriculture projects, and therefore empowering them as local agents of change.

Participation plays an important role also in the approach proposed by Blixen Magariños et al. (2007). Basing their approach on the MESMIS framework (López-Ridaura et al., 2002), these researchers stress the highly context-specific nature of sustainability assessment, which requires a participatory process for the adaptation of the assessment methodology to the local context. They also focus on five sustainability attributes of agroecosystems: (i) productivity, (ii) stability, (iii) resilience, (iv) adaptability, (v) autonomy. In their application of the approach to the evaluation of a community program for food production in Montevideo, Uruguay, they identified 36 indicators, which were measured through 67 wide-ranging variables (e.g., to capture farm management, soil quality, land tenure, labor management, work culture, dependency on external inputs, among others).

Similarly, Beilin and Hunter (2011) developed a participatory approach for scientists, community gardeners, and local authorities to co-produce indicators to assess the sustainability of urban gardens in Sydney. The approach resulted in three sets of (i) social, (ii) ecological, and (iii) local food production indicators. These were highly place-specific and highly relevant to the governance of urban agriculture in the city. The development of indicators improved the relations among community gardeners, local authorities, and other community groups, and also enabled the monitoring and revising of the governance system in order to smooth factors that were limiting urban agriculture's potential (e.g., official registration of gardening sites).

Stakeholder participation and expert opinions also play an important role in the method developed by Landert et al. (2017). This sustainability assessment method for urban-food-

system governance explicitly aims to be holistic (i.e., to cover all relevant aspects of an urban food system), and to enable comparison between cities. This method has a specific focus on the extent to which the urban food system is governed sustainably by local politics and administration, and is informed by the guidelines for Sustainability Assessment of Food and Agriculture Systems proposed by the FAO. Accordingly, the method defines sustainability in terms of good governance, environmental integrity, economic resilience, and social well-being. "These four dimensions are divided into 21 themes with 58 subthemes in total. . . . For each of the 58 subthemes, a goal is defined to evaluate the sustainability of farms or businesses along the food value chain" (Landert et al., 2017). Indicators are defined for each subtheme based on stakeholder participation, relevance, and data availability, and are then weighted through an expert-informed process. In an application of the method to the Swiss city of Basel, Landert et al. (2017) used a total of 97 indicators.

In other cases, the assessment is based on a set of indicators that is predefined and not developed with stakeholders. For instance, Losada et al. (2001) evaluated the economic productivity and sustainability of growing the nopal vegetable (*Opuntia ficus-indica*) in Mexico City. For this purpose, they used three sets of economic, social, and environmental indicators and collected data through a survey of 100 urban farmers. Economic indicators included a gross margin analysis, commercialization strategies, and provision of employment. Social indicators were the education level, family size, and origin of laborers; plot size, which provided a measure of equity; and social self-organization. Environmental indicators were soil nutrient content and fertilizer application, technological management, and crop and natural biodiversity. For each farm, the results of the assessment were scored on a scale from zero to 100.

Finally, some researchers have transferred and adapted general sustainability assessment methods to the urban context. For example, Drechsel and Dongus (2010) used an adapted version of the Framework for Evaluating Sustainable Land Management (FESLM) developed by the FAO to assess the sustainability of urban agriculture in Dar es Salaam, Tanzania. According to the FESLM, sustainable land management relies on five pillars: (i) maintenance or enhancement of production/services, (i) reduction of the level of production risk, (iii) protection of the potential of natural resources and prevention of degradation of soil and water quality, (iv) economic viability, (v) social acceptability. Drechsel and Dongus (2010) used mostly secondary data (interviews, official statistics, maps, and remote sensing data) available from previous studies. Like Soler Montiel and Rivera-Ferre (2010), Drechsel and Dongus (2010) did not predefine any specific indicators. Instead, they adopted a more descriptive, data-driven approach that attempted to capture the dynamics of urban agriculture regarding the five pillars, whereby further insight is provided by the comparison with other African cities where similar data were available.

17.4 Sustainability of Urban Agriculture: Challenges and Opportunities

The previous two sections have presented conceptualizations of urban agriculture (see Section 17.2) and illustrated the range of sustainability assessment methods that have been employed in the Global North and South (see Section 17.3). These sections have shown that

urban agriculture is not only highly diverse socially, environmentally, technically, economically, institutionally, and culturally, but also highly contested. Urban agriculture has been, in cities in the North as well as in the South, an arena of political struggle, and of governmental and non-governmental intervention. It has been used to promote various and often contradictory visions of sustainability, health, food, citizenship, and development. To reiterate: the diversity of urban agriculture forms, the multifunctionality of peri-urban spaces where urban agriculture largely takes place, contested framings of urban agriculture, and the difficulties involved in integrating and incorporating different types of knowledge and land use into urban planning often result in the failure to create institutional, policy, and planning arrangements that are conducive to sustainable urban agriculture (de Zeeuw & Dubbeling, 2009; Lerner et al., 2013; Olsson et al., 2016; Pearson et al., 2010). Furthermore, our discussion has illustrated the absence of established formalized methods for assessing the sustainability of urban agriculture specifically. While a sophisticated toolbox for the assessment of agricultural sustainability in general exists, not many methods have been specifically developed for urban agriculture although, as shown (see Section 17.2), urban agriculture presents crucial differences from agriculture in rural contexts.

This section develops the above analysis to identify some key challenges that the theory and practice of sustainability assessment of urban agriculture pose to researchers. The analysis is structured according to three dimensions of sustainability assessment as defined by Binder et al. (2010) (and see Chapter 1 (Halla & Binder, 2020)), namely normative, procedural, and systemic (Table 17.2).

17.4.1 Normative Dimension

Urban agriculture is often the object of, or even a tool for the contestation of, divergent visions of sustainable development. From political gardening to resistance to land appropriation for urban expansion, from debates around the supposedly inherent sustainability of local

Table 17.2 *Main challenges faced in the sustainability assessment of urban agriculture*

Normative	Procedural	Systemic
Sustainability concept, goal-setting, and assessment type	Preparatory/setup phase, indicator selection; measurement, assessment, application, follow-up	Systemic representation and indicator interaction
Setting assessment goals Mediating potentially conflicting stakeholder interests Defining sustainability Defining indicator weightings	Need for dedicated investigation strategies Sustaining participation	Identifying the system's boundaries Establishing indicator interactions, especially with non-agricultural system components (built environment, buffer zones)

production to debates about the regeneration of urban systems, urban agriculture is often interrelated with deep-seated cultural meanings, socioeconomic objectives, and political imaginaries (Certomá & Tornaghi, 2015; Goodman et al., 2012; Sahakian et al., 2016; Tornaghi, 2014). Ultimately, the different ways in which urban agriculture has been conceptualized, can be traced back to fundamentally different notions of human well-being (see Chapter 3 (Meinherz et al., 2020)). For example, anthropocentric and technocentric worldviews, as opposed to organic ones, are reflected in varying combinations of market, subsistence, or agroecological models of urban agriculture (see Chapter 3 (Meinherz et al., 2020)).

This has important implications (Table 17.2) for the normative dimension of the sustainability assessment of urban agriculture, which is only compounded by the striking diversity of urban agriculture, the presence of a relatively mobile and diverse population, and the proximity and complementarity of agricultural and non-agricultural activities, all of which extend the range of possible stakeholders and blur the boundaries of the system to be assessed.

The high number and diversity of stakeholders, and the fact that urban agriculture may be a part-time income-generating activity, suggests that the assessment's goal-setting may be challenging and that it may be necessary to mediate among conflicting interests, not only across but also within the farming and non-farming populations. While many sustainability assessment methods assume that the local authority will set up the assessment, most methods entail some form of public participation, which may involve the definition of the assessment goal. Nevertheless, most methods reviewed in the previous section also predefine sustainability to a significant extent, for example identifying specific dimensions or pillars of sustainability (Table 17.3). It is unclear to what extent these definitions of

Table 17.3 *Sustainability dimensions in selected methods for sustainability assessment of urban agriculture*

Source	Dimensions
Beilin & Hunter (2011)	Social, ecological, local food production
Blixen Magariños et al. (2007)	Productivity, stability, resilience, adaptability, autonomy
Drechsel & Dongus (2010)	Maintenance or enhancement of production/services, reduction of the level of production risk, protection of the potential of natural resources and prevention of degradation of soil and water quality, economic viability, social and political acceptability
FAO (2007)	Productivity, land tenure security, protection of environment and people, economic viability, social and political acceptability, and ability to form cooperatives
Landert et al. (2017)	Good governance, environmental integrity, economic resilience, and social well-being
Losada et al. (2001)	Economic, social, environmental
Soler Montiel & Rivera-Ferre (2010)	Access to resources, production model, transformation and commercialization, food consumption and right to nutritious food, agricultural policies, and civil society organization

sustainability may fit different purposes and contexts of urban agriculture, if they are compatible with the underlying worldviews of different stakeholders, and how they may be received by diverse populations and by policy-makers.

Moreover, while some methods take an explicitly normative position, for example by adopting an agroecology perspective (Soler Montiel & Rivera Ferre, 2010), others are presented as less normatively charged. However, the latter too, by defining and operationalizing sustainability, take strong normative positions that implicitly exclude other possible understandings of sustainable urban agriculture (e.g., Drechsel & Dongus, 2010; see also Goldstein et al., 2016b). More subtly, indicator weightings reflect normative notions of sustainability. They may raise further challenges not only in a given context, where different stakeholders may disagree on attributed weightings, but also regarding the use of a selected assessment method in contexts where urban agriculture may have different purposes (e.g., income generation) from the context in which the method was originally developed (e.g., social inclusion). These issues, and more broadly the question of the transferability of the assessment method to distinct urban contexts, are hardly addressed in the methods reviewed in this chapter, and therefore represent an important area for future research (see also Barrett et al., 2017).

Furthermore, the above-mentioned implications underscore the importance of a careful contextualization of the sustainability assessment by which the conditions for the assessment are explicitly identified (see Chapter 1 (Halla & Binder, 2020)). These include how sustainability is conceptualized by different stakeholders, which underlying worldviews have shaped these conceptualizations, how these worldviews are rooted in the socioeconomic and socioecological context in which they are expressed, and how the assessment would feed into the governance process itself. By making these assumptions and their socioeconomic and socioecological embeddedness explicit, a common definition of sustainability could potentially emerge, which would then serve to inform the research design and assessment tools.

17.4.2 Procedural Dimension

Two main challenges can be identified with respect to the procedural dimension of the sustainability assessment of urban agriculture, namely the need for what Certomá and Tornaghi (2015) call "dedicated investigation strategies," and the difficulties in defining the user group and in sustaining participation (Table 17.2).

First, and in relation to the previous discussion, the often contested and political nature of urban agriculture raises questions about the role of the researchers in the sustainability assessment process. While it is out of the scope of this chapter to discuss in detail the possible forms of scientist-activism configurations in sustainability and critical scholarship (see for example: Pickerill, 2008; Tornaghi & van Dyck, 2015), it is important to highlight that the sustainability assessment of urban agriculture may, even more than for agriculture in rural spaces, challenge the position of the researchers and their practices (Tornaghi & van Dyck, 2015). The political nature of urban agriculture makes it difficult to escape the normative basis and implications of research practice, and therefore not only "poses methodological questions and calls for dedicated investigation strategies, it also requires

an understanding of the reasons for, and effects of, their personal engagement, far beyond their mere commitment to reciprocity" (Certomá & Tornaghi, 2015 p. 1127). The methods illustrated in the previous section take distinct approaches to this issue along a broad spectrum from a critical but active engagement (Soler Montiel & Rivera-Ferre, 2010) to substantially neutral positions (Beilin & Hunter, 2011; Losada et al., 2001). Nonetheless, these examples suggest that the urgency of the questions regarding the researcher's political and normative position, and therefore the need to develop appropriate "dedicated investigation strategies," may depend not only on the researcher's own beliefs and approach to investigation, but critically on the level of political struggle and contestation in the specific system under investigation.

A second procedural challenge relates to sustaining participation. This issue may arise from the often higher mobility of the urban population, and especially in peri-urban spaces, as compared to people living in rural areas and settlements. Peri-urban areas are often spaces of temporary immigration in which people may engage in farming activities. Moreover, urban agriculture may often be only one of a number of income-generating activities for urban residents. More generally, urban citizens may show less attachment to place than rural ones (Anton & Lawrence, 2014). Therefore, for example, a mobile urban population may make it difficult to identify a community of interest, and to secure community participation especially in a lengthy participatory process. Moreover, even when participation may be secured, it is more likely that those who participated in the preparation and selection of the indicators may not be the same participants who may be called upon to follow up on them, or who reap the benefits of any sustainability-enhancing intervention. In fact, the characteristic of a mobile population may be relevant even for sustainability assessment methods that do not entail stakeholder participation but, for instance, rely on other forms of data collection such as surveys or interviews. In those cases, the assessment may be based on data related to farming activities or participants that are not those who will benefit or be influenced by any follow-up interventions.

A further challenge to sustaining participation in the sustainability assessment of urban agriculture is posed by the more heterogeneous population of urban as compared to rural systems. First, urban farmers may have other jobs or activities and therefore differential time pressures, may be spatially unevenly distributed, and may be subject to different social responsibilities and expectations, as in the case of female versus male farmers in different ethnic or cultural groups, or social classes. Second, given the proximity of agricultural and non-agricultural activities that is typical of urban systems, non-farmer stakeholders are also more diverse than in many rural contexts. Therefore, devising participatory strategies that encourage and enable the participation of such a diverse farmer and non-farmer population may be difficult logistically as well as at a normative level (as discussed). However, none of the approaches and methods illustrated in the previous sections address, in a substantial manner, the potential issue raised by mobile, heterogeneous urban populations with little attachment to place. This is an important area of methodological development for sustainability assessment of urban agriculture.

One possibility to address some of the challenges outlined may consist in employing transdisciplinary sustainability assessment approaches, which entail the engagement of relevant stakeholders in defining a given problem, and the participatory codesign of an approach for research and action (Binder et al., 2010; de Zeeuw & Drechsel, 2015). Transdisciplinary approaches are not immune from power dynamics (see Chapter 4 (Fritz & Meinherz, 2020)) but offer ways to recognize and deal with them in designing and conducting the assessment.

17.4.3 Systemic Dimension

Urban agriculture is often spatially and socially interstitial: it is not necessarily practiced in open fields, but in vacant lots, on rooftops as well as in backyards (Certomá & Tornaghi, 2015). Moreover, it is often spatially and socially porous: it is practiced by professional farmers as well as by citizens in their free time, in private as well as in public spaces. Thus, urban agriculture often has soft boundaries and strong interactions and complementarity with its non-agricultural context; due to such proximity and interactions, both the positive (e.g., psychological benefits from a greener urban landscape) and the negative (e.g., water pollution) effects of urban agriculture can easily spill over. On account of this, it is often difficult to clearly identify the unit of analysis or any separations between a garden or urban farm and the system in which it is environmentally, infrastructurally, and socially embedded. For example, many urban and peri-urban farms are parts of short food supply chains in which consumers purchase the produce directly on the farm, sometimes actively participating in field maintenance and harvesting, as in community-supported agriculture schemes. These experiences not only shorten food supply chains, but also blur the boundaries between production, retail, and consumption. This has important implications for sustainability assessment. However, as illustrated by the diversity of methods presented in the previous section, there appears to be no established approach that can deal with this aspect of urban agriculture, since assessment methods may (Landert et al., 2017) or may not (Goldstein et al., 2016b; Losada et al., 2001) include system components beyond the farm.

It is also important to note that the examples of assessment methods presented do not include interactions among the indicators. This may be a sign of a lower level of sophistication of these methods compared to other sustainability assessment methods that do consider those interactions (Binder et al., 2010). The lack of consideration for interactions among indicators may reflect an emphasis on the social rather than the environmental dimension, as discussed previously regarding the normative dimension. On the other hand, it could also reflect the difficulty of representing mathematically or computationally the interactions between environmental, agronomic, and infrastructural (built environment) components of the system, thus again underscoring the challenge posed by the mixed nature of urban and peri-urban systems for the assessment of urban agriculture.

Interdisciplinary approaches offer a way forward to understand system complexity in sustainability assessment. Methods from the social and environmental sciences, as well as interpretivist and positivist approaches, can be fruitfully combined to build awareness and

understanding of the interrelationship between the different elements and processes, as well as their hierarchical relations. For example, interpretivist methods can help identify system boundaries through thick descriptions of the different and interrelating elements that make up an urban or peri-urban system, while being sensitive to multiple and possibly conflicting views of the system (see Chapter 8 (Binder et al., 2020a)). This can then lead to a quantification and qualification of material and energy flows (e.g., Karg et al., 2016; Leray et al. 2016), while the drivers of these flows can then be determined through social science approaches (e.g., Binder, 2007).

17.5 Conclusions

Governance is central to ensuring urban agriculture's nutritional, economic, social, and environmental positive outcomes are maximized, while its potential negative impacts are avoided or minimized. Sustainability assessment can play an important role as part of broader governance strategies to support sustainable urban agriculture and sustainable urban food systems more broadly. However, this chapter has shown that there is a paucity of assessment methods that have been developed specifically for urban agriculture and are flexible enough to be immediately applicable for different forms of urban agriculture in different contexts.

Sustainability assessment of agriculture has usually focused on agriculture for market production in relatively stable rural contexts. However, urban agriculture poses challenges that many existing sustainability assessment approaches and methods fail to address. The diversity of urban agriculture forms, the multifunctionality of peri-urban spaces where urban agriculture largely takes place, contested framings of urban agriculture, and the difficulties involved in integrating and incorporating different types of knowledge and land use into urban planning often result in the failure to create institutional, policy, and planning arrangements that are conducive to sustainable urban agriculture.

Some of the challenges identified in this chapter are not unique to urban agriculture. Agriculture is often contested regardless of whether it occurs in an urban or rural system, and rural farmers often have multiple employments and can be mobile, e.g., seeking seasonal employment in different places and economic sectors. Nevertheless, as has been amply discussed in the literature and in this chapter, these characteristics manifest more acutely in urban and peri-urban spaces due to the specific nature of urban systems.

This chapter has suggested some opportunities to move the practice of sustainability assessment of urban agriculture forward. These include the adoption of inter- and transdisciplinary research strategies, and a critical approach to urban agriculture practices, power relations, social norms, and institutional conditions that have developed over time in specific contexts. A reflexive research approach and "dedicated investigation strategies" may also go a long way in supporting the sustainability assessment of urban agriculture. But there are no silver bullets or predetermined solutions to the challenges identified in this chapter. Ultimately, sustainability assessment of urban agriculture may be a litmus test for

governance arrangements to support agriculture in urban and peri-urban spaces, and for research approaches that can contribute to sustainable development.

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References

Anton, C. E., & Lawrence, C. (2014). Home is where the heart is: The effect of place of residence on place attachment and community participation. *Journal of Environmental Psychology*, 40, 451–461.

Badami, M. G., & Ramankutty, N. (2015). Urban agriculture and food security: A critique based on an assessment of urban land constraints. *Global Food Security*, 4, 8–15.

Baker, S. E. (2012). *Evaluating the Feasibility of Urban Agriculture on Oakland's Private Land*. (Bachelor's thesis). University of Berkeley.

Barrett, T., Feola, G., Krylova, V., & Khusnitdinova, M. (2017). The application of Rapid Appraisal of Agricultural Innovation Systems (RAAIS) to agricultural adaptation to climate change in Kazakhstan: A critical evaluation. *Agricultural Systems*, 151, 106–113.

Beilin, R., & Hunter, A. (2011). Co-constructing the sustainable city: How indicators help us "grow" more than just food in community gardens. *Local Environment*, 16, 523–538.

Binder, C. R, Hutter, M., Pang, M., & Webb, R. (2020). System science and sustainability assessment. In C. R. Binder, E. Massaro, & R. Wyss (eds.), *Sustainability Assessment in Urban Systems*. Cambridge University Press, pp. 30–64.

Binder, C. R., Feola, G., & Steinberger, J. K. (2010). Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. *Environmental Impact Assessment Review*, 30, 71–81.

Binder, C. (2007). From material flow analysis to material flow management Part I: social sciences modeling approaches coupled to MFA. *Journal of Cleaner Production*, 15, 1596–1604.

Blixen Magariños, C., Colnago Vieyto, P., González Jiménez, N., Márquez Scotti, C., & Chiappe Hernández, M. (2007). Indicadores de sostenibilidad para la agricultura urbana. I seminario de cooperación y desarrollo en espacios rurales iberoamericanos. *Sostenibilidad e indicadores. Almeria*, 16–17 Octubre, 2007

Certomá, C., & Tornaghi, C. (2015). Political gardening: Transforming cities and political agency. *Local Environment*, 20(10), 1123–1131.

Chappell, M. J., Wittman, H., Bacon, C. M., et al. (2013). Food sovereignty: An alternative paradigm for poverty reduction and biodiversity conservation in Latin America. *F1000Research*, 2, 235.

De Bon, H., Parrot, L., & Moustier, P. (2010). Sustainable urban agriculture in developing countries. A review. *Agronomy for Sustainable Development*, 30, 21–32.

de Zeeuw, H. (2004). The development of Urban Agriculture; some lessons learnt. Keynote presented at the conference Urban Agriculture, Agro-tourism and City Region Development, Beijing, 10–14 October.

de Zeeuw, H., & Dubbeling, M. (2009). Cities, food and agriculture: Challenges and the way forward. Presented at the technical consultation Agriculture, Food and Cities, Rome, 24–25 September.

de Zeeuw, H., & Drechsel, P. (Eds.) (2015). *Cities and Agriculture: Developing Resilient Urban Food Systems*. London: Routledge.

Drechsel, P., Graefe, S., Sonou, M., & Cofie, O. O. (2006). Informal Irrigation In Urban West Africa: An Overview. Research Report Series. Colombo, Sri Lanka: International Water Management Institute.
Drechsel, P., & Dongus, S. (2010). Dynamics and sustainability of urban agriculture: examples from sub-Saharan Africa. *Sustainability Science*, 5(1), 69.
Drechsel, P., & Keraita, B. (Eds.) (2014). *Irrigated Urban Vegetable Production in Ghana: Characteristics, Benefits and Risk Mitigation*, 2nd edition. Colombo, Sri Lanka: International Water Management Institute (IWMI).
Eigenbrod, C., & Gruda, N. (2015). Urban vegetable for food security in cities: A review. *Agronomy for Sustainable Development*, 35, 483–498.
FAO (1996). *The State of Food and Agriculture*. Rome: FAO.
FAO (1999). Committee on Agriculture – COAG/FAO. Urban and peri-urban agriculture. OAG/99/10. Presented at the Fifteenth Session of the COAG. 25–29 January. Rome: FAO.
FAO (2007). Profitability and sustainability of urban and peri-urban agriculture. *Agricultural Management, Marketing and Finance Occasional Paper*. Rome: FAO.
Farming Concrete (2015). *Farming Concrete Data Collection Toolkit*. New York: Design Trust for Public Space
Fritz, L., & Meinherz, F. (2020). The politics of participatory sustainability assessments: An analysis of power. In C. R. Binder, E. Massaro, & R. Wyss (eds.), *Sustainability Assessment in Urban Systems*. Cambridge University Press, pp. 87–122.
Galluzzi, G., Eyzaguirre, P., & Negri, V. (2010). Home gardens: Neglected hotspots of agro-biodiversity and cultural diversity. *Biodiversity and Conservation*, 19, 3635–3654.
Gasparatos, A., & Scolobig, A. (2012). Choosing the most appropriate sustainability assessment tool. *Ecological Economics*, 80, 1–7.
Ghosh, S. (2014). Measuring sustainability performance of local food production in home gardens. *Local Environment*, 19(1), 33–55.
Godin, L., & Sahakian, M. (2018). Cutting through conflicting prescriptions: How guidelines inform "healthy and sustainable" diets in Switzerland. *Appetite*, 130, 123–133.
Goldstein, B. P., Hauschild, M. Z., Fernández, J. E., & Birkved, M. (2017). Contributions of local farming to urban sustainability in the northeast United States. *Environmental Science & Technology*, 51, 7340–7349.
Goldstein, B., Hauschild, M., Fernández, J., & Birkved, M. (2016a). Urban versus conventional agriculture, taxonomy of resource profiles: A review. *Agronomy for Sustainable Development*, 36(1), 9.
Goldstein, B., Hauschild, M., Fernández, J., & Birkved, M. (2016b). Testing the environmental performance of urban agriculture as a food supply in northern climates. *Journal of Cleaner Production*, 135, 984–994.
Goodman, D., Du Puis, M., & Goodman, M. K. (2012). *Alternative Food Networks: Knowledge, Practice, and Politics*. London: Routledge.
Grewal, S. S., & Grewal, P. S. (2012). Can cities become self-reliant in food? *Cities*, 29(1), 1–11.
Halla, P., & Binder, C. R. (2020). Sustainability Assessment: Introduction and Framework. In C. R. Binder, E. Massaro, & R. Wyss (eds.), *Sustainability Assessment in Urban Systems*. Cambridge University Press, pp. 7–29.
Hashim, N. (2015). Reversing food desertification: Examining urban farming in Louisville, Chicago and Detroit. *Local Environment*, 20(6), 611–636.
Karg, H., Drechsel, P., Akoto-Danso, E. K., Glaser, R., Nyarko, G., & Buerkert, A. (2016). Foodsheds and city region food systems in two West African cities. *Sustainability*, 8(12), 1175.
Kulak, M., Graves, A., & Chatterton, J. (2013). Reducing greenhouse gas emissions with urban agriculture: A life cycle assessment perspective. *Landscape and Urban Planning*, 111, 68–78.
Landert, J., Schader, C., Moschitz, H., & Stolze, M. (2017). A holistic sustainability assessment method for urban food system governance. *Sustainability*, 9(4), 490.
Lang, U. (2014). Cultivating the sustainable city: Urban agriculture policies and gardening projects in Minneapolis, Minnesota. *Urban Geography*, 35, 477–485.
Leray, L., Sahakian, M., & Erkman. S. (2016). Understanding household food metabolism: Relating micro-level material flow analysis to consumption practices. *Journal of Cleaner Production*, 125, 44–55.

Lerner, A. M., & Eakin, H. (2011). An obsolete dichotomy? Rethinking the rural-urban interface in terms of food security and production in the Global South. *The Geographical Journal*, 177, 311–320.

Lerner, A. M., Eakin, H., & Sweeney, S. (2013). Understanding peri-urban maize production through an examination of household livelihoods in the Toluca Metropolitan Area, Mexico. *Journal of Rural Studies*, 30, 52–63.

Lin, B. B., Philpott, S. M., & Jha, S. (2015). The future of urban agriculture and biodiversity-ecosystem services: Challenges and next steps. *Basic and Applied Ecology*, 16, 189–201.

López-Ridaura, S., Masera, O., & Astier, M. (2002). Evaluating the sustainability of complex socio-environmental systems: The MESMIS framework. *Ecological Indicators*, 2, 135–148.

Losada, H., Vieyra, J., Soriano, R., Bennett, R., Cortés, J., & Zavaleta, P. (2001). Assessing the sustainability of a terraced agroecosystem for production of nopal vegetable (Opuntia ficus-indica) in metropolitan Mexico City. *American Journal of Alternative Agriculture*, 16(3), 98–105.

Madaleno, I. M., & Gurovich, A. (2004). "Urban versus rural" no longer matches reality: An early public agro-residential development in periurban Santiago, Chile. *Cities*, 21, 513–526.

Marshall, F., Dolley, J., Randhawa, P., et al. (2017). Why Peri-urban Ecosystem Services Matter for Urban Policy (Policy Briefing). ESPA briefing. Brighton: STEPS Centre.

McClintock, N. (2014). Radical, reformist, and garden-variety neoliberal: Coming to terms with urban agriculture's contradictions. *Local Environment*, 19(2), 147–171.

McClintock, N., Cooper, J., & Khandeshi, S. (2013). Assessing the potential contribution of vacant land to urban vegetable production and consumption in Oakland, California. *Landscape and Urban Planning*, 111, 46–58.

Meinherz, F., Fritz, L., & Schneider, F. (2020). How Values Play into Sustainability Assessments: Challenges and a Possible Way Forward. In C. R. Binder, E. Massaro, & R. Wyss (eds.), *Sustainability Assessment in Urban Systems*. Cambridge University Press, pp. 65–86.

Mendez, M., Ramirez, L., & Alzate, A. (2005) La práctica de la agricultura urbana como expresión de emergencia de nuevas ruralidades: reflexiones en torno a la evidencia empírica. *Cuadernos de Desarrollo Rural*, 55, 51–70.

Mougeot, L. J. (2005). *Agropolis: The Social, Political and Environmental Dimensions of Urban Agriculture*. IDRC/London: Earthscan.

Olsson, E., Kerselaers, E., Søderkvist Kristensen, L., Primdahl, J., Rogge, E., & Wästfelt, A. (2016). Peri-urban food production and its relation to urban resilience. *Sustainability*, 8, 1340.

Orsini, F., Kahane, R., Nono-Womdim, R., & Gianquinto, G. (2013). Urban agriculture in the developing world: A review. *Agronomy for Sustainable Development*, 33, 695–720.

Ortega Cerdà, M., & Rivera-Ferre, M. G. (2010). Indicadores internacionales de Soberanía Alimentaria. Nuevas herramientas para una nueva agricultura. *Revibec: revista de la Red Iberoamericana de Economia Ecológica*, 14, 53–77.

Pearson, L. J., Pearson, L., & Pearson, C. J. (2010.) Sustainable urban agriculture: Stocktake and opportunities. *International Journal of Agricultural Sustainability*, 8, 7–19.

Pérez-Martinez, M. E. (2016). Las territorialidades urbano rurales contemporaneas: un debate epistémico y metodológico para su abordaje. *Bitácora*, 26(2), 103–112.

Pickerill, J. (2008). The surprising sense of hope. *Antipode*, 40(3), 482–487.

Plessz, M., Dubuisson-Quellier, S., Gojard, S., & Barrey, S. (2016). How consumption prescriptions affect food practices: Assessing the roles of household resources and life-course events. *Journal of Consumer Culture*, 16(1), 101–123.

Poulsen, M. N. (2017). Cultivating citizenship, equity, and social inclusion? Putting civic agriculture into practice through urban farming. *Agriculture and Human Values*, 34, 135–148.

Poulsen, M. N., McNab, P. R., Clayton, M. L., & Neff, R. A. (2015). A systematic review of urban agriculture and food security impacts in low-income countries. *Food Policy*, 55, 131–146.

Quon, S. (1999). *Planning for Urban Agriculture: A Review of Tools and Strategies for Urban Planners*. Cities Feeding People series, report 28. Ottawa: International Development Research Centre.

Rabinovitch, J., & Schmetzer, H. (1997). Urban agriculture: Food, jobs and sustainable cities. *Agriculture and Rural Development* 4(2), 44–45.

Ringenbach, J., Valcourt, M., & Wang, W. (2013) Mapping the Potential for Urban Agriculture in Worcester: A Land Inventory Assessment. Interactive Qualifying Projects (All Departments). 2644. Worcester Polytechnic Institute.

Saha, M., & Eckelman, M. J. (2017). Growing fresh fruits and vegetables in an urban landscape: A geospatial assessment of ground level and rooftop urban agriculture potential in Boston, USA. *Landscape and Urban Planning*, 165, 130–141.

Sahakian, M., Saloma, C., & Erkman, S. (Eds.) (2016). *Food Consumption in the City: Practices and Patterns in Urban Asia and the Pacific*. Oxford: Routledge.

Saldivar-Tanaka, L., & Krasny, M. E. (2004). Culturing community development, neighborhood open space, and civic agriculture: The case of Latino community gardens in New York City. *Agriculture and Human Values*, 21(4), 399–412.

Savoie-Roskos, M. R., Wengreen, H., & Durward, C. (2017). Increasing fruit and vegetable intake among children and youth through gardening-based interventions: A systematic review. *Journal of the Academy of Nutrition and Dietetics*, 117(2), 240–250.

Schmidt, S., Magigi, W., & Godfrey, B. (2015). The organization of urban agriculture: Farmer associations and urbanization in Tanzania. *Cities*, 42, 153–159.

Shinew, K. J., Glover, T. D., & Parry, D. C. (2004). Leisure spaces as potential sites for interracial interaction: Community gardens in urban areas. *Journal of Leisure Research*, 36(3), 336.

Soler Montiel, M., & Rivera Ferre M. (2010). Agricultura urbana, sostenibilidad y soberanía alimentaria: hacia una propuesta de indicadores desde la agroecología. Actas del X Congreso Español de Sociología FES (Federación Española de Sociología), Sociología y sociedad en España.

Thebo, A. L., Drechsel, P., & Lambin, E. F. (2014). Global assessment of urban and peri-urban agriculture: Irrigated and rainfed croplands. *Environmental Research Letters*, 9(114002).

Teo, T. A., & Wu, H. M. (2017). Analysis of land cover classification using multi-wavelength LiDAR system. *Applied Sciences*, 7(7), 663.

Tornaghi, C. (2014). Critical geography of urban agriculture. *Progress in Human Geography*, 38, 551–567.

Tornaghi, C., & Van Dyck, B. (2015). Research-informed gardening activism: Steering the public food and land agenda. *Local Environment*, 20(10), 1247–1264.

Van Veenhuizen, René (Ed.) (2006). *Cities Farming for the Future: Urban Agriculture for Green and Productive Cities*. RUAF Foundation, IDRC and IIRR.

Warren, E., Hawkesworth, S., & Knai, C. (2015). Investigating the association between urban agriculture and food security, dietary diversity, and nutritional status: A systematic literature review. *Food Policy*, 53, 54–66.

Zezza, A., & Tasciotti, L. (2010). Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries. *Food Policy*, 35, 265–273.

Zundritsch, P. (2018). Cartography of Potential Sites for Urban Gardening in Lausanne. Semester project, École Polytechnique Fédérale de Lausanne.