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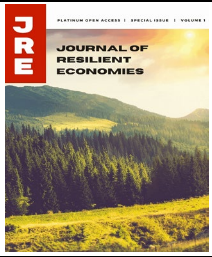

The Role of Urban Agriculture in Enhancing Urban Food System Sustainability and Resilience: a Literature Review

Tong Zou[1], Ali Cheshmehzangi[2] , Ayotunde Dawodu [3] , Eugenio Mangi[4]

Abstract

During the COVID-19 pandemic, cities around the world have gone through terrible ordeals. These include a lack of urban resilience in emergency response, food supply, institutional cooperation, economic support, etc. Meanwhile, many urban and global problems have been amplified by the pandemic's impacts on food security issues, the long-term sustainability of food systems, and so on. In response to the recovery agenda of the post-COVID 19 eras, rebuilding urban resilience and sustainability through sustainable urban food system development pathways has great potential. It is evident that food supports the fundamental needs of people's health and well-being, but cities account for most food consumption, waste, and greenhouse gas emissions. Starting from these considerations, this study investigates how urban agriculture can improve the sustainability and resilience of the urban food system through the analysis of the existing literature. Conducted on April 11, 2022, on the Web of Science database, this literature review includes bibliographic coupling, co-citation analysis, and co-occurrence analysis to map knowledge regarding the role of urban agriculture practices in fostering urban food systems' 'sustainability' and 'resilience'. The findings of the study highlight different aspects that include more general considerations, e.g., urban agriculture alone cannot substitute large-scale food systems in the short term, but it could be a promising approach in the future, and more detailed aspects, such as the geographical recurrence of this kind of research and the most popular scientific journals addressing these topics.

Keywords: Urban Agriculture; Food Systems; Sustainability; Resilience; Cities

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1. Introduction

The recent pandemic of COVID-19 has been posing unprecedented negative impacts to global supply chains, undermining food security at all scales and bringing catastrophic chain effects to decrease the overall food system sustainability level. This COVID pandemic makes the world rethink and pursue a sustainable transition of the current food system and supply chain landscape in the long term (Aubry & Kebir, 2013; Grando et al., 2017), while short food supply chains would highlight the significance of local markets in defending vulnerable groups from food insecurities as well as fostering foo system sustainability and urban resilience when facing any future unexpected shocks like the pandemic (Nchanji & Lutomia, 2021). Since most of the world's population lives in cities (United Nations, 2018), producing food in urban areas can be considered the most optimal option to shorten the food supply chain, attracting growing attention in both research and practices of Urban Agriculture (UA).

UA is a primary production process that can be seen as a component entrenched in urban food systems interreacting with urban resources, energy, and material flows, while it has been utilised as an all-encompassing term for different practices and scenarios (Weidner et al., 2019). In the literature, UA is defined in various ways, such as "growing and raising food crops and animals in an urban setting for the purpose of feeding local populations" (Sanyé-Mengual et al., 2019)(Sanyé-Mengual et al., 2019); "the production of food in or around urban areas", and so on. On the other hand, the notion of Urban and Peri-Urban Agriculture (UPA) has also been brought to this area of study, which extends the scope of UA. This means "an industry located within or on the fringe of an urban area, using in situ products, services and human and natural resources, to grow, process and distribute agricultural products" (Benis & Ferrão, 2017) or "activities located within or on the fringe of an urban area and related to the growth, processing, and distribution of agricultural and livestock products" (Mancini et al., 2021). Furthermore, it is claimed that the concept of UA and city region food systems (CRFS) have been involved and developed with other terms like agricultural urbanism, agrarian urbanism, food urbanism, edible urbanism, metropolitan agriculture, edible green infrastructure, continuous productive urban landscape (CPUL) (Russo & Cirella, 2019).

UA practices have an extensive diversity and variety in terms of size, goals, scopes, motivation, applications, and stakeholders, covering from educational projects and community-orientated projects to commercial framing schemes (Sanyé-Mengual et al., 2019) while involving multiple institutional norms, governmental policies, cultural attributes, etc. (Weidner et al., 2019). In recent years, UA practices have evolved into diverse forms, including allotment gardens, community gardens, rooftops, indoor farms, vertical farming (VF), and building-integrated agriculture (BIA) in response to the challenges and impacts of urban sprawl, climate change, environmental degradation, population growth, socio-economic inequalities and also institutional challenges (Benis & Ferrão, 2017; Wielemaker et al., 2019; Kuusaana et al., 2022). For example, one key issue of rapid urbanisation is the continuous fast transformation of prime agricultural land in the urban periphery to commercial and residential housing resulting in rising prices of rural land in land markets (Kuusaana et al., 2022).

It is well recognised that UA practices can promote urban sustainability with numerous social, environmental, and social benefits as a very effective intervention (Wielemaker et al., 2019), a multi-faced approach (Wielemaker et al., 2019), and a strategy to resolve a breadth of environmental, social, and human health issues (Weidner et al., 2019). For instance, local ecological and social response capacity against major collapse in urban food supplies can be fostered and enhanced through UA practices like urban gardening and urban social movements (Russo & Cirella, 2019). Moreover, Sanyé-Mengual et al. (2019) state that UA is also regarded as a promising way to support the self-sufficiency of food production at both household and city levels. Since it can increase local food provisioning while decreasing supply chains and transportation distances and further contribute to urban food system sustainability development (Benis & Ferrão, 2017). In short, it implies that food supply self-sufficiency and/or food security and food system sustainability are UA's primary fundamental benefits in practices.

In addition, it is argued that UA practices can boost innovations and novelties with its unique traits such as limited land access, different growing media, the involvement of non-traditional farms, non-production-related missions and so on (Sanyé-Mengual et al., 2019). Moreover, Kuusaana et al. (2022) claim that UA covers an exceptional economic niche and provis food sources and employment for a section of the urban population, particularly the poor and other socially disadvantageous groups. Other benefits suggested by existing research involve climate change mitigation, urban heat island effect reduction, biodiversity conservation and biosphere extension, increased urban water retention and infiltration, ecosystem services, enhancement of resource efficiency and circularity, promote social development and community cohesion, increased people's dietary variety and well-being, offer opportunities for employment, education and recreation (Benis & Ferrão, 2017; Weidner et al., 2019). Regarding sustainable development goals (SDGs), UG plays an important role in fulfilling zero hunger (SDG 2) and sustainable cities and communities (SDG 11) (Kuusaana et al., 2022). The global COVID-19 pandemic has been elevating the recognition of urban resilience's importance while growing evidence has been proving and illustrating multiple benefits of urban resilience; current studies on its relationships with UA are still very limited (Gulyas & Edmondson, 2021).

Moreover, it is evident that UA is critical to fostering sustainable development, while the role of UA in enhancing urban food system sustainability and resilience remains underexplored. UA plays a significant part in research studies on urban food systems, but there is little evidence related to SDGs and research. Based on the existing literature, a major research gap is identified, i.e., UA is rarely discussed in the nexus with urban food system sustainability and resilience. There is a need to systematically evaluate existing research to map knowledge regarding the role of urban agriculture practices in fostering both urban food system sustainability and resilience. Therefore, to investigate the importance of UA in building urban food system sustainability and resilience, this study will conduct a bibliographic analysis and interpret the implications. Methods and materials are covered in Section 2. Results and Discussion are illustrated in Section 3, followed by Section 4 with Summary and Conclusion. Section 3.3 and Section 3.4 cover detailed discussions based on interpreting the results.

2. Methods and Materials

This study consists of five steps, as shown in Figure 3. This study followed a systematic review process of the protocol of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). After the development of the search string, an initial search was conducted. All the related studies were retried online from the Web of Science database. The inclusion and exclusion criteria were applied during the literature selection stage to refine the results. Essential information related to PP, FS, and conflicts was extracted and recorded into Microsoft Excel sheets for further analysis. After that, a bibliographic analysis was conducted by VOSviewer. The initial search string was: TS=("urban agriculture "AND" food systems" AND ("sustainability" OR" resilience")).

The initial search on the Web of Science database on April 11, 2022, yielded 86 items. After that, the alert function was activated to cover the latest published papers in this study. No new articles were added between April 11 and April 17, 2022. After screening the abstracts, 20 articles were included for full-text review. Section 3.2 contains the results of the bibliographic analysis with brief descriptions.

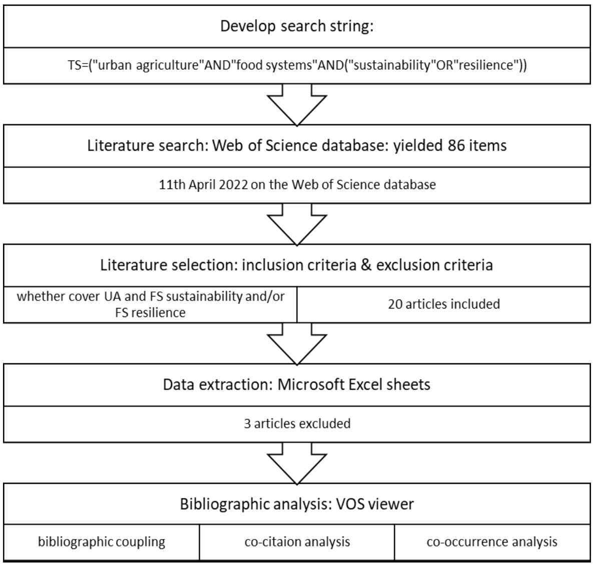

Figure 1- Research flow, source: the authors

The abstracts of the retrieved documents were reviewed to check whether they meet the two inclusion criteria:

- Covers UA and FS sustainability generally
- Covers UA and FS resilience generally

After scanning the abstracts, 20 articles met the inclusion criteria for full-text review. During the process of full-text review, documents were reviewed to check whether meeting the following exclusion criteria:

- Does not discuss any interactions/relationships between UA and sustainability
- Does not discuss any interactions/relationships between UA and resilience.

After reviewing the full articles, no additional articles from the reference list of included articles. One article was excluded due to language limitations (not in English); one article was excluded due to lack of access. Three articles that meet the exclusion criteria are excluded, and 15 documents that have discussed any types of interactions between adaptation and mitigation were selected to be included in the review. Finally, 15 articles remained in the databases.

3. Results and Discussion

Overview of the literature

In this paper, 15 articles were selected for in-depth analysis. Table 1 illustrates the detailed authors' names, the publication year of included studies, and their coverage of food system sustainability and resilience. It can tell that most articles were published after 2015, the establishment of the United Nations' SDGs. 74% of publications discussed UA and food system sustainability, and 60% of included articles discussed food system resilience. Only 33% of included literature covered sustainability and resilience simultaneously.

Table 1- Included publications and their coverage on food system sustainability and resilience

#	Authors	Food system sustainability	Food system resilience	Both
1	Ackerman et al. (2014).	X		
2	Benis & Ferrão (2017)	X	X	X
3	Buxton et al. (2016).		X	
4	da Cunha et al. (2020)	X		
5	Gulyas & Edmondson (2021).		X	
6	Kuusaana et al. (2022)	X		
7	Martin & Bustamante (2021)	X	X	X
8	Nchanji & Lutomia (2021)	X	X	X
9	Russo & Cirella (2019)	X	X	X
10	Sanyé-Mengual et al. (2019)	X	X	X
11	Taylor (2020)		X	
12	Weidner et al. (2019)	X		
13	Wielemaker et al. (2019)	X		
14	Yoshida & Yagi (2021)		X	
15	Zimmerer et al. (2021)	X		
Total%	N/A	74%	60%	33%

Bibliographic analysis

This study has employed four types of analysis. Respectively, they are co-occurrence analysis of keywords (Figure 2), co-citation analysis by the authors (Figure 3), co-citation analysis by citing the source (Figure 4), and bibliographic coupling by countries (Figure 5). Co-occurrence analysis of keywords is used to identify the most influential themes with the greatest inter-relationships in the research area, while the co-citation analysis is used to reveal relationships among cited publications and fundamental themes. Moreover, the bibliographic coupling can show relationships between citing publications and periodical/present themes (Donthu et al., 2021).

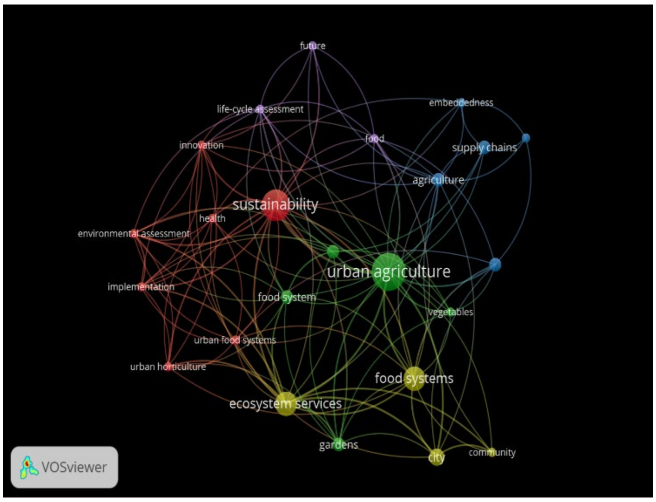

Figure 2- The co-occurrence map

Figure 2 illustrates the co-occurrence analysis of the keywords in the considered papers, with an occurrence threshold set at two. In this way, 24 terms met the occurrence threshold. At the same time, analysing VOSviewer's Total link strength attribute (van Eck & Waltman, 2017, p.6), it can be affirmed that keywords with the strongest links and highest occurrence have greater interrelations. This led to the definition of 5 main clusters in the co-occurrence map.

The largest cluster (red) contains seven items, including "sustainability", "urban food systems", "urban horticulture", "innovation", "implementation", "health", and "environmental assessment" while "sustainability" has the highest total link strength of 35 with the occurrence of 8 times. The second large cluster (green) has five items as follows: "urban agriculture", "food system", "greenhouse gas emissions", "gardens" and "vegetables". In this cluster, "urban agriculture" has the greatest total link strength of 37 with the occurrence of 10 times. The blue cluster also has five items, including "agriculture", "periurban agriculture", "embeddedness", "supply chain", and "quality". "agriculture" has the highest occurrence of 3 with the strongest total links of 13 in this blue cluster. The fourth cluster (yellow) has four items, covering "ecosystem services", "food systems", "city", and "community". The keyword with the best inter-relationship in this cluster is "ecosystem services", with a total link strength of 29 and occurrences of 6. The smallest cluster (purple) contains only three items: "life-cycle assessment", "food", and "future".

The most significant keyword within this cluster is "life-cycle assessment", which has a total link strength of 13 and occurrences of 2. In short, it can be argued that items falling into the same clusters have closer relationships with each other in research. In contrast, items with the highest total link strength have attracted the most research interest and attention in academia. Co-citation analysis reveals the most influential publications and journals in a specific study area, showing that the connections between two literature studies are cited by a particular third one (Van Eck and Waltman, 2009; Sharifi, 2021). Figure 3 shows the output of co-citation analysis by authors. Out of the 1050 authors cited in the included articles, 12 meet the threshold of 5 citations. The most popular authors with the highest citations are McClintock (7 citations), FAO (14 citations), and Sanye-Mengual (13 citations).

The result of co-citation analysis by site source meeting the threshold of 8 is illustrated in Figure 4; there are 3 clusters and 16 items/journals. The first (red) cluster contains eight items (e.g., Cities, Urban Studies, Land Use Policy, etc.). Sustainability has the strongest total link strength of 795, with 47 citations within this cluster. The second cluster (blue cluster) is dominated by the Journal of Clean Production, with total link strength of 688 (42 citations). The last cluster (green cluster) contains only three items from lowest to highest total link strength: Local Environment (178 with eight citations); Journal of Agriculture, Food Systems, and Community Development (231 with 11 citations); and Agriculture and Human Values (502 with 25 citations). It can tell that this field of study falls into urban sustainable development studies, agroecology studies, and environmental studies.

Figure 5 illustrates the output of bibliographic coupling analysis with a minimum threshold of 2 documents for a country. In total, 19 countries for 4 clusters are identified. The USA is the most influential country researching urban agriculture and food systems sustainability and resilience, followed by England, Spain, Germany, South Africa, Italy, etc.

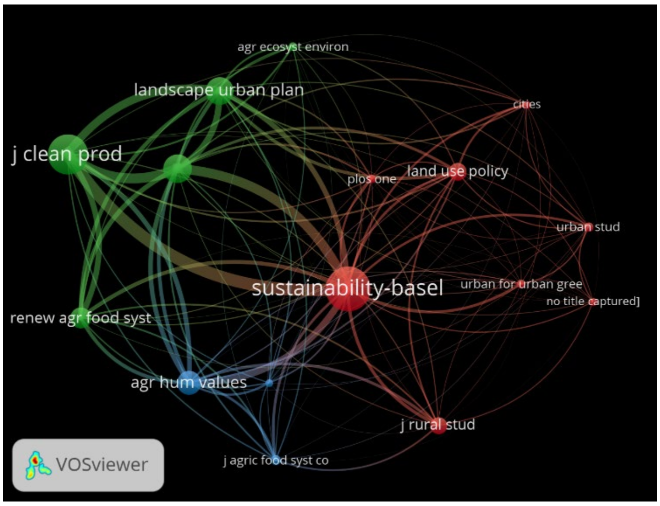

Figure 3- The co-citation by the cite source map

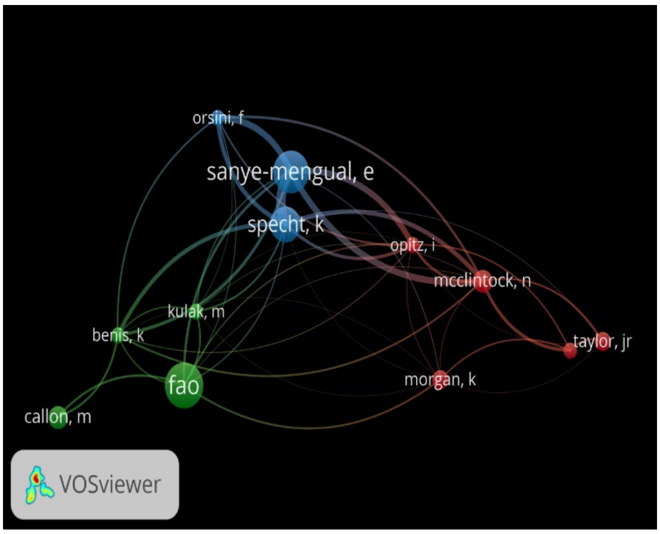

Figure 4- The co-citation by the author map

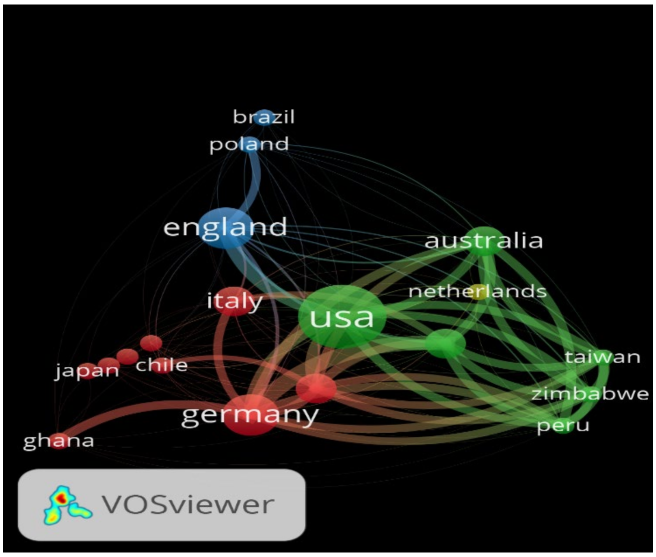

Figure 5- The bibliographic coupling by countries map

The leading position with the largest label size implies researchers/authors from the USA have very close collaborations with researchers from other countries. The first cluster (red) contains nine countries with the highest total link strength to the lowest: Germany, Spain, Italy, Ghana, Chile, Sweden, Kenya, Portugal, and Japan. The second cluster (green) includes the USA, South Africa, Australia, Peru, Taiwan, and Zimbabwe. England, Poland, and Brazil make up the third cluster (blue), and the Netherlands is the last cluster (yellow) by it alone. Countries within the same clusters suggest significant-close connections and frequent collaborations between their scholars when conducting research in this field of study. Also, this may imply that the levels or stages of urban agriculture research for those countries are similar. At the same time, they share a similar context and/or situations regarding urban agriculture and food systems sustainability.

Urban Agriculture and FS sustainability

A sustainable food system (SFS) is defined as "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised" (Guarnaccia et al., 2020, pp.1). Food security is defined as "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" at the World Food Summit in 1996 (United Nations Food and Agriculture Organization (FAO), 2008, pp.1). It can tell that food security reflects the physical, economic, and nutritious dimensions of the food supply. Besides that, SFS also emphasises the importance of social, temporal, and environmental-friendly dimensions of food supply. Combining two sets of dimensions, it can be argued that six aspects can be identified for food system sustainability, including physical accessibility, economic affordability, healthy nutrition, social inclusiveness, stable persistence, and environmental friendliness.

Table 2 illustrates the benefits and types of UA covered in the included publications regarding the six aspects of food system sustainability. It can tell that the majority of articles covering food system sustainability focused on the aspect of environmental friendliness with a proportion of 47%. This reflects that the most significant value of UA practices in terms of sustainable development is environmental sustainability, which is agreed by its unique features like ecosystem services, improved urban greens, biodiversity protection, etc. Secondly, 44% of publications covered economic affordability, implying that UA can significantly reduce food costs by providing an alternative food supply source and shortening the supply chain. Both social inclusiveness and physical accessibility have the third-highest frequency of coverage at 33%. Followed by healthy nutrition (27%), food system sustainability in general (27%), and stable persistence (13%).

More specifically, UA practices are very effective strategies for improving environmental sustainability. Multiple evidence can be found in various types of UA like edible green infrastructure (EGI), Salvador urban gardens, private, community gardens, and growing-service systems" (GSS) (da Cunha et al., 2020; Russo & Cirella, 2019; Martin & Bustamante, 2021). For instance, it is argued that urban and peri-urban agriculture can make great contributions to minimising negative environmental impacts of the urban food system as it can dramatically reduce the food losses and waste along with the whole food supply via a relatively short transportation distance of food as well as its associated costs and emissions (Benis & Ferrão, 2017). Urban farms and community gardens can help mitigate urban heat island effects, improve stormwater management, and reduce the energy embodied in the provisioning and distributing phases of the food supply chain (Ackerman et al., 2014). Under the increasing impacts of rapid globalisation, short food supply chains are developed to foster sustainable food production and consumption. Nchanji & Lutomia (2021) point out that UA can drastically cut greenhouse gas emissions via shortened food supply chains. Another environmental benefit of UA is recovering and reusing nutrients and organic matter from urban wastes, re-introducing those nutrients into the food system and restoring the nutrient cycle through UA practices (Wielemaker et al., 2019). For instance, utilising compost and animal manure as bio-fertilisers are wide-spreading in urban farming.

Table 2- Urban agriculture and aspects of food system sustainability

Aspects	Publications ID	Examples of UA or its benefits	Total%
Physical accessibility	2, 4, 8, 9, 15	Edible urbanism; Salvador urban gardens; shortening transportation distances	33%
Economic affordability	1, 4, 7, 8, 9, 10	Edible urbanism; urban-vertical farms; growing-service systems (GSS); reduced costs due to self-production; contribute to a household's income, offset food expenditures, and create jobs	40%
Healthy nutrition	4, 8, 9, 15	Edible urbanism; urban, private and community gardens; secure food, and nutritional needs of rural and urban households	27%
Social inclusiveness	1, 8, 9, 10, 15	Edible urbanism; mental health benefits; Edible Green Infrastructure (EGI); cultural exchange; community self-organisation; community cohesions; maintenance of cultural heritage; enhancing the common social and cultural identity for city residents; secure livelihoods and incomes needs of rural and urban households	33%
Stable persistence	4, 9	Edible urbanism; urban, private and community gardens	13%
Environmental friendliness	1, 2, 4, 7, 8, 10, 13	Salvador urban gardens; urban and peri urban agriculture; short food supply chain; growing-service systems" (GSS); restoring the nutrient cycle; urban-vertical farms; reduction of food miles and transport emissions; carbon sequestration; microclimate regulation; soil preservation; help reduce urban heat island effects, mitigate urban stormwater impacts, and lower the energy embodied in food transportation; reducing losses and wastage,	47%
Food system sustainability	1, 8, 10, 13,	Sustainable consumption and production behaviour; strengthen local economies and small businesses; economic stability	27%

In speaking of economic sustainability, UA can potentially reinforce local economies and small businesses while supporting commodity outputs (Sanyé-Mengual et al., 2019) and offset households' food expenses (Ackerman et al., 2014). Economic stability and cost reduction owing to food self-sufficiency were found to have higher relativities to greater degrees of sustainability (Sanyé-Mengual et al., 2019). Moreover, Nchanji & Lutomia (2021) state that short food supply chains can support and secure livelihoods and incomes of both rural and urban households against the negative impacts of the COVID pandemic and promote sustainable consumption and production behaviours as well eventually. While UA is a very effective approach for shortening the food supply chain, it can be noted that UA is also vital to fostering economic food system sustainability.

For social inclusiveness and social sustainability, UA is found to have multiple advantages in terms of connecting consumers to food growers (Russo & Cirella, 2019), supporting education, deepening community cohesion, culture exchange, keeping cultural heritage, and even improving mental health (Sanyé-Mengual et al., 2019; Zimmerer et al., 2021). Furthermore, it is claimed that large-scale UA practices like larger urban farms can also contribute to community enrichment through education training, most of which profits vulnerable and other socially disadvantageous groups (Ackerman et al., 2014).

Moreover, Nchanji & Lutomia (2021) argue that shortening food system supply chains can also moderate the adverse impacts of diverse pandemics for poor and socially disadvantageous population groups while elevating the key role of circular economy in sustainable urbanism and food system. Since food production is a fundamental ecosystem service provided by UA, its nutritional benefits to food system sustainability are undoubted, like protein intake, nutritional security, diet diversity and an easy way to satisfy people's nutritional nee aided by shorter supply chains (Zimmerer et al., 2021; da Cunha et al., 2020; Nchanji & Lutomia, 2021).

On the other hand, UA can also bring some negative impacts to urban sustainability as well as FS sustainability. In a study examining how nutrients are managed in UA in the Netherlands; the results indicate that overusing of fertilisers in UA practices leads to a wide range of nutrient surpluses, threatening local water and soil quality and further undermining both food system sustainability and urban sustainability (Wielemaker et al., 2019). In particular, the authors found that mean nutrient inputs surpassed mean crop demand by approximately 450% for total nitrogen (N), 600% for phosphorus (P), and 250% for potassium (K) (Wielemaker et al., 2019). It calls for the need to enhance nutrient management in UA. Secondly, UA agriculture can also threaten urban sustainability and city ecosystems via great demand for energy consumption. Russo & Cirella (2019) argue that light-emitting diode (LED) lights for substituting sunlight in fenestrated buildings and its heat emission and running humidity control and air circulation systems can all generate very high energy costs. UA practices do not always deliver the usual ecological pros, for instance, indoor controlled environment practices that do not always provide ecosystem serveries or ecological benefits like biodiversity enrichment or urban heat island effect mitigation (Weidner et al., 2019).

In general, the roles of UA in supporting food security and enhancing food system sustainability from environmental, economic, and social perspectives are recognised by various studies and urban practices (Weidner et al., 2019; Martin & Bustamante, 2021). The extensive literature agrees upon the benefits and advantages of UA in terms of sustainable development. One of the most influential co-benefits is shortening the food supply chain, which acts as a multiplier of UA's contributions to each aspect of the urban sustainable food system.

Urban Agriculture and FS resilience

Food system resilience is defined as the "capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances" (Tendall et al., 2015, pp.19). It overlaps with some features of food system sustainability, particularly in maintaining a certain level of food security. "Sufficient" and "accessible" reflect physical accessibility, economic affordability, and stable persistence. At the same time, "appropriate" may cover healthy nutrition, social inclusiveness, environmental friendliness, and cultural acceptance. There are two key points of this concept. The first is timing when the food system faces multiple unexpected disturbances. The second is about "multiple levels". UA is subjected to urban level, but it can be scaled up to national and global levels and gets started from individual and community levels; reflecting those benefits of UA can go beyond city boundaries.

In this study, 60% of UA-related publications mentioned resilience, while most only discussed resilience in general or sustainability. UA practices can localise the food system, shorten food supply, enhance both food supply chain resilience (Benis & Ferrão, 2017) and agri-food system resilience (Nchanji & Lutomia, 2021) benefit food system sustainability. Those are achieved by increasing food security, developing social capital, fostering circular economies (Gulyas & Edmondson, 2021), diversifying food sources, reducing the energy costs along the whole food supply chain, reusing urban waste for irrigation and production in UA practices (Buxton et al., 2016). For instance, multiple case studies suggest that UA can increase environmental resilience in terms of enhanced knowledge and food production capacity (Sanyé-Mengual et al., 2019). One study finds that home gardening in urban and peri-urban areas improved people's resilience to food and nutritional shortfalls during the COVID-19 pandemic (Nchanji & Lutomia, 2021), implying the huge potential of UA in offsetting the impacts of supply chain disturbances caused by pandemic prevention and control strategies.

Some UA practices and related concepts have merged resilience thinking into their inspiring motivations and/or fundamental basis, such as growing-service systems (Martin & Bustamante, 2021), edible urbanism (Russo & Cirella, 2019), etc. Moreover, it is argued by Gulyas & Edmondson (2021) that additional contributions of UA practices expand to multiple areas, including offering a means of regular exercise to urban growers, decreasing the likelihood of non-transmissible disease within the urban population, boosting cooperation of cities in facing of sudden shocks like pandemic outbreaks, terroristic activities, and natural disasters.

Besides UA practices in cities, it is also suggested by Zimmerer et al. (2021) that a combined social and ecological investigation of UA can facilitate resolutions that magnify the sustainability and resilience of food systems and urban regions. With respect to rising future environmental and socio-economic shocks to the food system, five key elements are suggested to help UA improve urban resilience effectively. UA's scale, the extent to which it is combined into the urban fabric, inclusiveness, food-producing efficiency, and consideration of people's and environmental safety (Gulyas & Edmondson, 2021). To secure successful UA practices for building urban resilience, Gulyas & Edmondson (2021) also suggest that considering multiple actors is essential, while an interdisciplinary and holistic approach covering different knowledge is needed in future UA research and practices.

4. Summary and Conclusion

In summary, this study investigates the role of UA in improving the sustainability and resilience of the urban food system. Most included publications discussed UA and food system sustainability together (74%), while the least covered sustainability and resilience simultaneously (33%). Co-occurrence analysis found the most influential keywords with the greatest inter-relationships in this study area are "ecosystem services", "agriculture" (13), "life-cycle assessment", "urban agriculture", and "sustainability" from the highest total link strength to the lowest. The top three leading authors in this field of research identified by co-citation analysis are McClintock, FAO, and Sanye-Mengual, while the most popular journals are Sustainability, Journal of Clean Production, and Agriculture and Human Values. Bibliographic coupling analysis reveals the top six dominating countries undertaking this kind of research are the USA, England, Spain, Germany, South Africa, and Italy.

For food system sustainability, the benefits of UA fall into six main categories with different rates of coverage in the literature from the greatest to the least: environmental friendliness (47%), economic affordability (40%), social inclusiveness (33%), physical accessibility (33%), healthy nutrition (27%), food system sustainability in general (27%) and stable persistence (13%). UA's negative impacts are also mentioned in the literature, including poor nutrition management and nutrition overusing, intensive energy costs and usage for environmental condition control, the relatively high price of urban food, and limited environmental and ecological benefits of some types of UA.

On the other hand, publications covering UA and food system resilience are with fewer details. The short food supply chain is highlighted in building and reinforcing co-benefits of resilience and sustainability of food systems and cities as one of the major contributions of UA practices. Considerations of social inclusion and boosting different stakeholders' inputs are emphasised as critical points to foster resilience for disruptions like pandemic outbreaks, terroristic activities, and natural disasters.

Undoubtedly, UA alone cannot substitute large-scale food systems in the short term, while it is a promising approach to foster resilience and sustainability of urban food systems and urban areas. It is shown that the challenges of UA research challenges across numerous social levels (e.g., individual, community) and spatial scales and settings (e.g., cities, towns and villages, core urban, urban fringe or peri-urban, an individual plot, landscape) (Zimmerer et al., 2021). Meanwhile, lacking consideration of local context and multistakeholder engagement in UA design and implementations are also noted as major obstacles in urban practices (Sanyé-Mengual et al., 2019). Thirdly, mitigation strategies and solutions for UA's existing and possible negative impacts (e.g., high energy costs, nutrient surpluses, high product price) are essential for the large-scale promotion of UA practices.

With respect to current challenges and limitations of UA research, Ackerman et al. (2014) suggest that implementation of UA extensions at higher education institutions in city centres could enrich and boost the relevant knowledge and expertise and hence make the best use of UA for urban residents. For issues linked to scales, setting, and contexts, systematic thinking, multistakeholder engagement, and context-specific solutions are suggested to maximise the contribution of UA practices in building resilience and sustainability of urban food systems. Gulyas & Edmondson (2021) state more research on ecosystem provision capacity and social determinants of UA are needed for future studies. Other future directions may involve exploring the applications of smart technologies in UA, integrated energy and water-saving systems for UA, enhancement of UA's nutritional value, social and cultural aspects of UA, and so on.

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