

Cultivating sustainable and healthy cities: A systematic literature review of the outcomes of urban and peri-urban agriculture

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ABSTRACT

Despite considerable interest in urban and peri-urban agriculture (UPA) in recent decades, its contributions to urban sustainability and human wellbeing remain contested. This systematic literature review examines the geographical landscape of the peer-reviewed literature on UPA and assesses its reported outcomes on sustainability and wellbeing. Following systematic review protocols, we undertook a two-step literature screening and quality assessment process. From a total of 4029 articles, based inclusion-exclusion criteria, we filtered 320 articles for quantitative and 86 for qualitative assessment. Quantitative analysis confirmed an exponential increase in literature on UPA since 2015 and a regional bias towards the Global North. The qualitative analysis identified six thematic outcomes of UPA under three sustainability pillars - environmental sustainability; material well-being; labour and livelihoods; land tenure and urban planning; and food and nutritional security as part of economic sustainability; and subjective and relational wellbeing as well as gender and social differentiation as elements of social sustainability. Environmental sustainability was most discussed, followed by subjective wellbeing and food and nutritional security. Gender and social differentiation issues were least represented in the papers. There remain knowledge gaps around how urban policy and planning can recognise, leverage, and scale up the sustainability and wellbeing co-benefits of UPA.

1. Introduction

We are in the urban age. Currently, 56% of the global population lives in cities (UNDESA, 2018), which produce more than 80% of the global GDP (World Bank 2020). Alongside this urbanization, there has been a “geographical decoupling” (Langemeyer et al., 2021:2) of cities from sources of food supply, with urban and peri-urban land use being reoriented for higher-value uses. This reorientation of land use, growing urban populations, and new risks such as climate change and disease outbreaks; has meant that cities also concentrate risks. There is significant evidence of urban areas witnessing exacerbating environmental degradation and pollution; more frequent floods, cyclones, and heatwaves; and growing inequality (Pelling et al., 2021).

In this context of growing risk, calls for urban sustainability solutions are numerous, from nature-based solutions such as greening cities (Babí et al., 2021); infrastructural solutions such as retrofitting built infrastructure (Croce & Vettorato 2021); to socio-institutional solutions that change behaviours and urban governance systems (Singh et al., 2021). Amongst these, green infrastructure solutions are often identified as vehicles to achieve the triple goals of sustainable development, human well-being, and climate action (Langemeyer et al., 2021), through fostering biodiversity, maintaining air quality, recycling water resources, providing food and nutrition, improving public health, and inculcating pro-environment values that change behaviours and improve quality of life (Gill et al., 2007; Demuzere et al., 2014; Fink, 2016; Wamsler et al., 2016; Meerow & Newell, 2017).

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Table 1
Search terms.

"urban agriculture" OR "peri-urban agriculture" OR "urban farm*" OR "peri-urban farm*" OR "green infrastructure" OR "urban greening" OR "city farm*"				
AND				
"Sustainable" OR "Sustainability"				
AND				
Economic	OR	Environmental	OR	Societal
"economy*" OR		"environment*" OR		"social cohesion" OR
"economic" OR		"ecosystem		"social anomie" OR
"income*" OR		service*" OR "land		"quality of life" OR
"material well-being" OR		use*" OR "water		"happiness" OR
"financial asset*" OR		use*" OR		"unhappiness" OR
"household		"environmental		"well-being" OR
income*" OR		resource flow" OR		"Wellbeing" OR
"household		"air quality" OR		"Relational well-being" OR "Relational
capital" OR		"climate change" OR		well-being" OR
"economic		"food security" OR		"Subjective
development"		"biodiversity" OR		wellbeing" OR
		"soil" OR "nutrient		"Relational well-being" OR
		deficiency*" OR		"contentment" OR
		"micro-climate*"		"discontentment" OR
				"community" OR
				"social capital" OR
				"work burden*" OR
				"burden*"

Table 2
Type of UA/UPA.

Type of UA/UPA	No. of papers	Percentage (%)
Private open space	183	50%
Formal allotments	60	16%
Other	42	11%
Rooftop/terrace/balcony	33	9%
Encroached common spaces	28	8%
Greenhouses	11	3%
Vertical gardening	9	2%
Total	366	

Urban and peri-urban agriculture (UPA) is one such green infrastructure option, most commonly described as "horticultural, agricultural, and farming activities carried out on small plots of land in and around urban centres" (Ackerman et al., 2014:190). UPA has been lauded for its potential positive impacts on all three pillars of sustainability (Ackerman et al., 2014; Azunre et al., 2019), including enhanced dietary diversity, contribution to ecosystem services and improvements in the social quality of city spaces and peoples' lives (Maxwell et al., 1999; Ackerman et al., 2014; Lwasa et al., 2014; Padgham et al., 2015; Soga et al., 2017; Azunre et al., 2019; Mancebo & Certoma, 2019; Fanfani et al., 2022). There is evidence of UPA reducing indoor temperatures (Walters & Midden, 2018), promoting organic household waste recycling, and lowering energy embodied in food transportation (Ackerman et al., 2014). UPA can also foster social cohesion and community empowerment, enabling bottom-up innovation and localised sustainability solutions (White & Stirling, 2013; Wendelboe-Nelson et al., 2019; Chalmin-Pui et al., 2021).

Critics have, however, called for caution, citing that the scale of UPA impacts is often fragmented and insignificant at city levels (Badami & Ramankutty, 2015). UPA might also exacerbate inequalities and injustices along lines of gender or race (Horst et al., 2017; Mancebo & Certoma, 2019). For example, in Morogoro, Tanzania, UPA bolsters household incomes but can increase women's work burdens (Mntambo, 2017). In Bangalore, India the use of chemical fertilisers and wastewater for irrigation is having negative health impacts (Patil et al., 2018). This conflicting evidence of UPA as good or bad, worth scaling up or not, is the primary starting point of our enquiry.

A second motivator was our hypothesis that most of the literature on

UPA is dominated by temperate countries in the Global North, with lesser emphasis on the rapidly urbanising cities of the Global South. For instance, Wendelboe-Nelson et al. (2019) reviewed 241 studies on mental wellbeing and green spaces including gardens and urban farms, of which 208 were from North America, Europe, and Australia; a similar regional gap is noted by Soga et al. (2017) and Malberg Dyg et al. (2020). This hypothesis, if true, signifies a critical knowledge gap. For illustration, Delhi will see a 25% population increase by 2030, becoming home to 39 million people; the 15 fastest-growing cities are all located in Africa, and projected to nearly double their populations by 2035 (UNDESA, 2018). This recognition of large-scale urban growth in the Global South also highlights the need to examine how UPA can offer wellbeing benefits in these rapidly transitioning urban areas.

Given the acknowledgement of cities as critical to climate-resilient and sustainable futures (Bazaz et al., 2018; Bai et al., 2018), and the growing and evolving nature of the literature on UPA, we conduct a systematic literature review to examine the sustainability and wellbeing outcomes of UPA globally. The specific questions we examine are: 'What is the landscape of the literature on UPA and what are the sustainability and wellbeing outcomes of UPA?'. Sustainability and wellbeing outcomes are assessed because they are considered wide enough to fit with global calls for solutions that work for people and nature (IPBES 2019, IPCC 2018), with the potential to simultaneously leverage cities to address environmental concerns and meet goals of 'leaving no one behind' (UNSCB, 2017).

Section 2 details the systematic review methodological approach used. The findings are discussed in two parts: Section 3.1 reports on broad patterns such as UPA outcomes reported most and their geographical coverage in the literature. Section 3.2 reports our qualitative assessment of a subset of 86 papers to highlight UPA outcomes on six themes mapped across the three sustainability pillars: environmental sustainability; economic security (material well-being, labour, and livelihoods; food and nutritional security; land tenure and urban planning); and social equity (subjective and relational wellbeing; and gender and social differentiation). While in Section 4, we discuss the major take-aways from both the quantitative and qualitative review, Section 5 focuses on implications of these findings for scaling up UPA as an urban sustainability solution that can also meet multiple Sustainable Development Goals (SDGs), and reflects on knowledge gaps. To our understanding, this exercise is novel in that it is the first comprehensive systematic review of the UPA literature globally.

2. Methodology

This review explores the landscape of literature on UPA and examines its sustainability and wellbeing outcomes. We detail the methodological approach in two steps.

2.1. Step 1: literature search and screening

Using search terms nested across the three dimensions of sustainability (Table 1), we identified 4853 articles from three databases: 'Scopus'; 'Web of Science', and 'PubMed'. After excluding 824 duplicate articles, we were left with 4029 articles for further analysis. We screened the 'title', 'abstract' and 'keywords' of each article by 'search terms', and applied four inclusion criteria: articles should have an explicit focus on urban and/or peri-urban agriculture, report on outcomes of UPA, not be review articles, and be in English. Application of these inclusion criteria further reduced the number to 1387 articles. These were then screened at the abstract level, leaving us with 448 articles.

2.2. Step 2: quality assessment

Subsequently, we conducted a full-text quality and score-based review of the shortlisted 448 articles, using a quality assessment tool, adapted from Yosef et al. (2015). We used nine criteria to score each

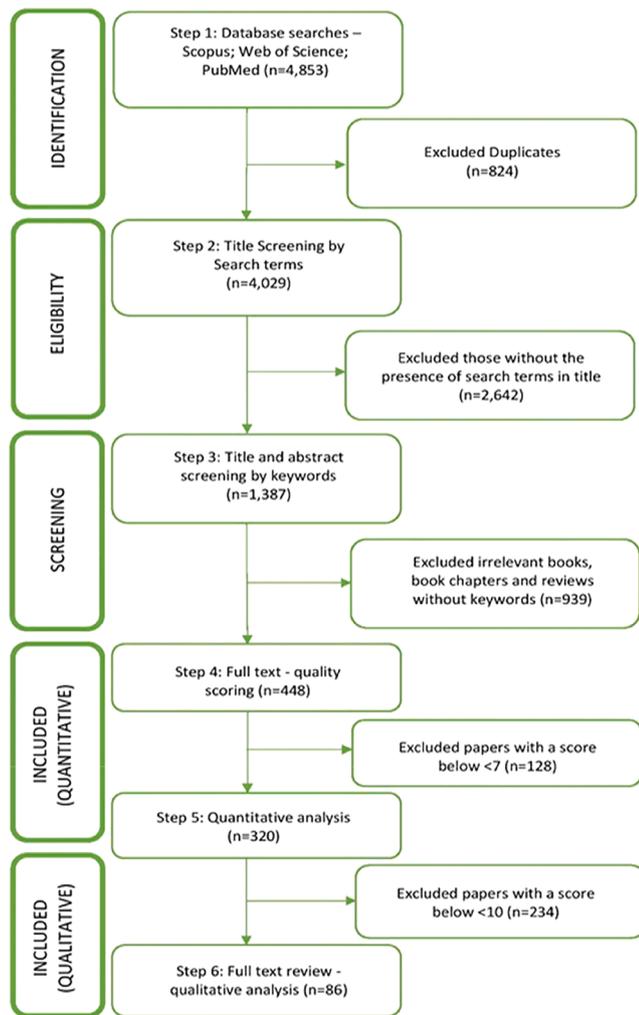


Fig. 1. Flowchart of literature screening process.



Fig. 2. Year of publication (n = 320).

article (see Table 1 in Appendix 1), which included acknowledgement of existing literature; clear articulation of a conceptual framework, research questions, limitations and research methods; suitability of indicators; generalizability of results and presence of a logical conclusion, with a total score ranging from 0 to 11. In addition to the quality scoring, we identified and distinguished articles by several thematic non-score-based categories (see Table 2 in Appendix 1).

Based on the scores, the 448 articles were divided into three categories – low quality (scores 0–6), medium quality (scores 7–9) and high quality (scores 10 and 11). About 29% (128 articles) with low scores were not considered for any further analysis. The remaining 71% (320

articles) are used for the descriptive analysis. For the qualitative, theme-based analysis, we focussed on ‘high quality’ articles scoring 10 or 11 (n = 86) (Table 1 in Appendix 2 lists all these articles). Fig. 1 summarises the step-by-step process of identifying, screening, and analysing articles.

3. Review findings

In this section, we first present the descriptive evidence from the papers with a quality score of 7 to 11, and then explore the sustainability and wellbeing themes emerging from the high-quality papers scored 10 and 11.

3.1. Descriptive analysis of UPA literature

There is a clear temporal trend in publications on UPA (Fig. 2) with more than 90% published after 2015. This exponential increase in articles is possibly linked to parallel global trends in recognising the importance of cities as places that concentrate risk and provide sustainability solutions: for example, the UN’s inclusion of SDG 11 signalled the importance of sustainable urbanization as one of the keystones of the 2030 Sustainable Development Agenda (Revi, 2017), a focus further articulated in the New Urban Agenda (UN-Habitat, 2016).

The articles spanned nine regions, the majority originating in the Global North (Fig. 3). The largest proportion of articles came from ‘Europe and UK’ (110), followed by ‘North America and Canada’ (60). Twenty-one articles covered multiple regions, whereas three articles did not mention any particular region. In the Global South, Sub-Saharan Africa (43) was best represented, followed by South-East and East Asia (33). Latin America is poorly captured, perhaps because our inclusion criteria only considered papers in English.

Most papers reported urban agriculture (n = 227), with fewer covering farming activities within urban and peri-urban settings (n = 52). We identified six distinct UPA ‘types’ and most reported were UPA within a ‘private open space’ followed by ‘formal allotments’ (Table 2) (see Table 3 in Appendix 1 that defines the UPA types).

Apart from location and type of UPA, personal consumption emerged as the main motivation (41%) for farming across regions, followed by utilising UPA as revenue for commercial gain and additional income creation (30%).

We identified 1330 keywords across 320 articles with medium and high-quality scores, with 359 keywords occurring more than 4 times. The most commonly used keywords included: ‘urban agriculture’ (n = 145), ‘food and nutritional security’ (n = 28), ‘sustainability’ (n = 23), ‘life-cycle assessment’ (n = 14), ‘community gardens’ (n = 12) and ‘green infrastructure’ (n = 12) (Fig. 4).

Six themes emerged from our preliminary analysis that fell under the three sustainability pillars (Table 3). Most articles discussed environmental issues, followed by food and nutrition security and wellbeing. Gender and social differentiation were least represented (Fig. 5).

3.1.1. Regions and themes

Articles from the Global North - ‘Europe and UK’, ‘North America and Canada’ and ‘Australia and New Zealand’ discussed environmental sustainability and UPA’s potential to address societal well-being. Articles based in the Global South also discussed issues concerning environmental sustainability and wellbeing predominantly, but the emphasis tended to be on ‘land and tenure security’, ‘food and nutritional security’ and concerns around ‘labour and livelihoods’ (Fig. 6). These differences are further discussed in Section 3.2.

3.1.2. Regions and impacts on sustainability pillars

We examined reported impacts of UPA on the three pillars of sustainability. Articles were less likely to discuss the impact of UPA on different economic indicators; however, UPA was regularly described for its positive contribution towards a range of social and environmental indicators (Table 4).

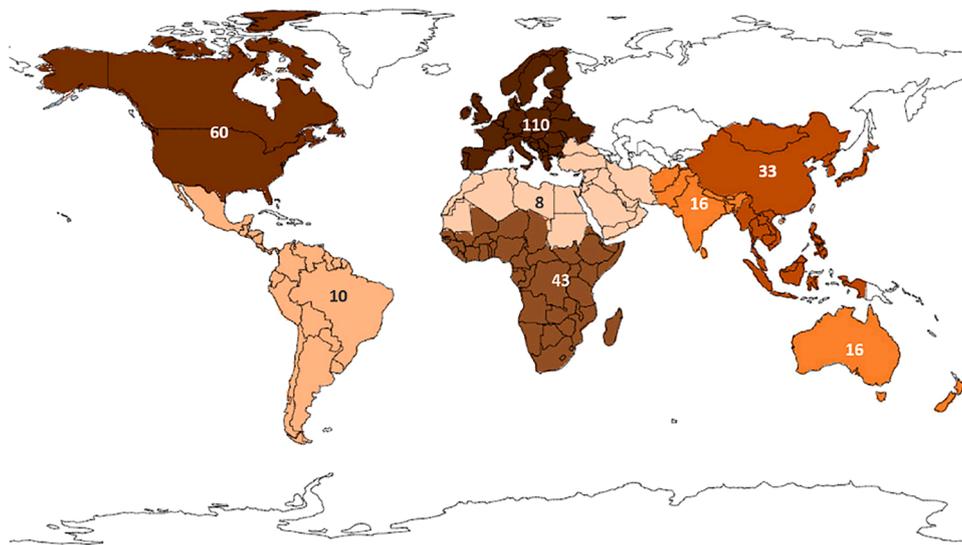


Fig. 3. Distribution of papers by region.

Specifically, papers from the Global North focused on positive environmental impacts, while those from the Global South, discussed UPA's benefits for social sustainability.

We now move to a more detailed qualitative discussion of the six themes identified as part of the descriptive analysis. Issues of scalability and governance cut across these themes and are discussed in the concluding section of the paper.

3.2. Thematic analysis of high-quality papers

Given the focus in the papers on environmental sustainability, we start this section with a discussion of this theme. We then move on to the economic sustainability pillar, within which we include three themes, namely, material well-being, labour and livelihoods; food and nutritional security; and land tenure and urban planning. We end this section with a discussion of social sustainability, as represented in two of our sub-themes, that is, subjective and relational wellbeing and gender and social differences.

3.2.1. Environmental sustainability

Of the 86 papers reviewed in-depth, 44 discuss environmental sustainability outcomes of UPA, demonstrating substantial research attention to environmental impacts of UPA. The papers are methodologically diverse, drawing on evidence from modelling, experimental, and perceptions-based assessments.

The links between UPA and environmental sustainability are mixed: on the one hand, studies discuss benefits such as reducing exposure to urban heat island effects, mitigating floods and stormwater overflow, recycling organic household and non-household waste, lowering energy embodied in food transportation (Ackerman et al. 2014; Azunre et al., 2019; Russo & Cirella 2020; Dorr et al., 2021; Knaus & Haase, 2020; Hu, Sun, & Zheng, 2021), and secondary benefits such as increased species diversity, improved nutrient cycling (Pungas, 2019), urban regeneration (Russo & Cirella, 2020), and greater environmental awareness (Diduck et al., 2020; Artmann & Sartison, 2018). On the other hand, farming in and around cities can have negative environmental impacts such as soil and water pollution due to overuse of chemical fertilisers (e.g., Abdulkadir et al., 2012; Ruff-Salís et al., 2021; Zhou et al., 2021). In peri-urban areas, these negative environmental impacts are often unevenly distributed, affecting low-income households more (Shokry et al., 2020; Grădinaru, 2018).

Meeting environmental sustainability goals is not always the primary motivating factor for UPA (e.g. Partalidou & Athopoulou, 2017;

Toboso-Chavero et al., 2021), but this evidence is differentiated regionally. Several papers in high-income countries point to expected environmental and health benefits as driving UPA (e.g., Kingsley, Foenander, & Bailey, 2019; Guitart et al., 2015; Mancini et al., 2021), while cases from Africa and Asia, highlight economic drivers as significant (e.g., Gilioli, 2015). We posit that this difference follows Maslow's hierarchy of needs (Abulof, 2017), where once material and physiological needs (food, water, shelter) are met, people turn to meeting goals that imbue meaning (meeting non-essential aspirations, cultivating hobbies, attending to emotional wellbeing) (see Partalidou & Athopoulou, 2017). In fact, such a shift from UPA being driven by material needs to being driven by subjective wellbeing needs is increasingly seen in transitioning economies in the Global South as well (e.g. Zasada et al., 2020; also see 3.2.5 on wellbeing).

On outcomes, the literature is divided into positive and negative outcomes in different geographies (see Appendix 3, Table 1). While Northern and Southern cities both report multidimensional positive outcomes such as improved biodiversity and species richness or sustainable urban planning, only Northern cities report climate mitigation benefits. This points to a significant gap in empirical studies on GHG mitigation outcomes of UPA in the Global South. On negative environmental outcomes, Southern cities tend to focus on pollution and waste generation trade-offs beyond city limits. Aubry et al. (2012) in Antananarivo, Madagascar demonstrate how urban farming can attenuate flood risk but have downstream negative impacts through increased water pollution. Northern cities report more on the inequitable social outcomes of UPA (e.g., exclusion of minority and low-income groups in elite sustainability narratives) (see Section 3.2.6). Overall, the evidence on the negative outcomes of UPA is somewhat limited.

Environmental outcomes are however not static, and UPA can be made more sustainable. For example, from Lyon (France) and Glasgow (Scotland), Weidner & Yang (2020) discuss how urban food production in greenhouses is energy-intensive and polluting through excessive chemical input use. However, these negative impacts can be mitigated by shifting to chemical-free farming or adding rainwater harvesting measures. Huang & Chang (2021) also discuss how coupling sustainable practices can improve sustainability outcomes such as in Taipei, where solar energy is used to pump rainwater for rooftop garden irrigation. Similarly, Toboso-Chavero et al. (2021), in Spain, demonstrate how rainwater harvested primarily for irrigating rooftop greenhouses is also used for electricity production.

Although the evidence is highly place-based and context-specific, the studies are well-spread across city types and sizes, UPA practices, and

Table 3
Sustainability Pillars and definitions of themes.

Sustainability Pillar	Theme	Theme Definition
Environmental	Environmental Sustainability	Environmental sustainability includes actions that protect, support, and restore ecosystem services and ecosystem functioning now and for future generations (developed from UNEP and IPBES)
	Material wellbeing, Labour and livelihoods	Material wellbeing can be understood in terms of human capital, such as education and health, access to jobs and livelihood opportunities, or other assets (White, 2010). Livelihoods and labour “comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base” (Chambers & Conway, 1991)
Economic	Land and Tenure Security	This theme highlights the role of local planning and policies (or the lack of it) that govern tenure security, and shape people’s ability “to control and manage land, use it, dispose of its produce and engage in transactions, including transfers” (IFAD, 2015). The way land is accessed and controlled by different stakeholders including the farm owners, farmworkers, local administrative bodies, etc greatly influences the sustainability outcomes of UPA
	Food and Nutritional Security	A multidimensional phenomenon where physical and economic access to sufficient, safe and nutritious food for all is ensured to meet daily dietary needs and lead an active and healthy life (developed from various FAO reports)
Social	Subjective and relational wellbeing	The subjective dimensions of wellbeing concern what people value and hold to be good, the desires they identify and how they feel about their lives (White, 2010). Relational dimensions of wellbeing include intimate relations of love and care as well as social networks and interactions with different people and institutions, including the state (White, 2010).
	Gender and Social Differentiation	The distinction made between different social groups and persons on the basis of biological, physiological, and sociocultural factors, such as sex, age, or ethnicity, resulting in the social construction of roles, relations, and statuses within a society.

socio-economic groups. Notably, UPA is increasingly being discussed as a key nature-based solution, at least in the Global North, possibly given a noticeable shift in the urban sustainability literature towards NbS (for more, see, Dorst et al., 2019; Artimann & Sartison, 2018).

3.2.2. Material wellbeing, labour and livelihoods

A key economic impact of UPA is its contribution to people’s livelihoods, the provision of employment and incomes, and relatedly, their



Fig. 4. Major keywords emerging from the literature.

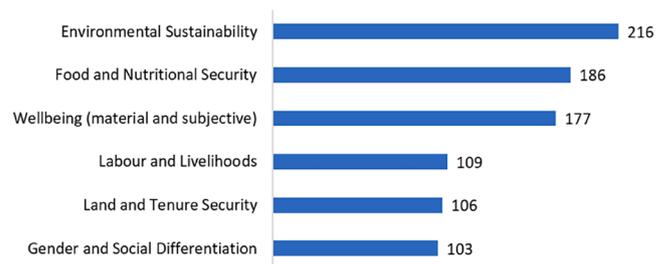


Fig. 5. Themes covered in reviewed articles (n = 320).

material wellbeing. 29 of 86 papers explore these issues mainly in countries of the Global South. UPA is an important means of livelihood for many urban dwellers, especially the poor, who engage in agricultural activities including field cropping, livestock keeping or commercial gardening as the or one of the key source(s) of household income and/or food supply (Abdulkadir et al., 2012; Aubry et al., 2012; Robineau & Dugue, 2018; Losada, 2000; Hammelman, 2021; de Oliveira & Ahmed, 2021; Thi et al., 2021; Khumalo et al., 2019). UPA projects supported by international and local development agencies conceive of these initiatives as alleviating poverty and improving food security, particularly in Sub-Saharan Africa, although with varied outcomes (Gilioli et al., 2015). Assessed through the lens of sustainable livelihoods, UPA’s contribution to livelihoods of the marginalized should not be interpreted in terms of economic efficiency alone, as it strengthens human and social capital as well, critical to empowering communities in the long run (Olivier, 2019; Surya et al., 2020).

Only a limited number of papers from the Global North discuss the potential of UPA projects to support livelihoods, create new jobs, offer entrepreneurship opportunities, and strengthen local economy with important economic implications for the urban poor (Gasperi et al., 2016; Delphino-Chamy et al., 2019; Lindemann, 2019; Krikser et al., 2019). For instance, Lindemann describes a community-driven grant funded UPA initiative in a predominantly poor and black neighbourhood in Cleveland, Ohio to showcase how this effort leveraged “... arts, culture, and food to promote placemaking and community-based entrepreneurial engagement” that not only benefits individuals, but also contributes to bottom-up community development and economic resilience (2019:1). Poulsen (2017) presents an important contrast between a community-driven and a for-profit UA initiative in two marginalised neighbourhoods of Baltimore, Maryland and discusses how both initiatives contribute to community upliftment, through different means, and with different degrees of equity implications for the local community.

Different UA models seem to have different economic implications. For instance, entrepreneurial rooftop farms in Montreal offer economic opportunity to many, by creating jobs and marketing other farmers’ products, while simultaneously posing a risk/competition for small scale and new farmers to sustain their businesses in the city (Allaby et al.,

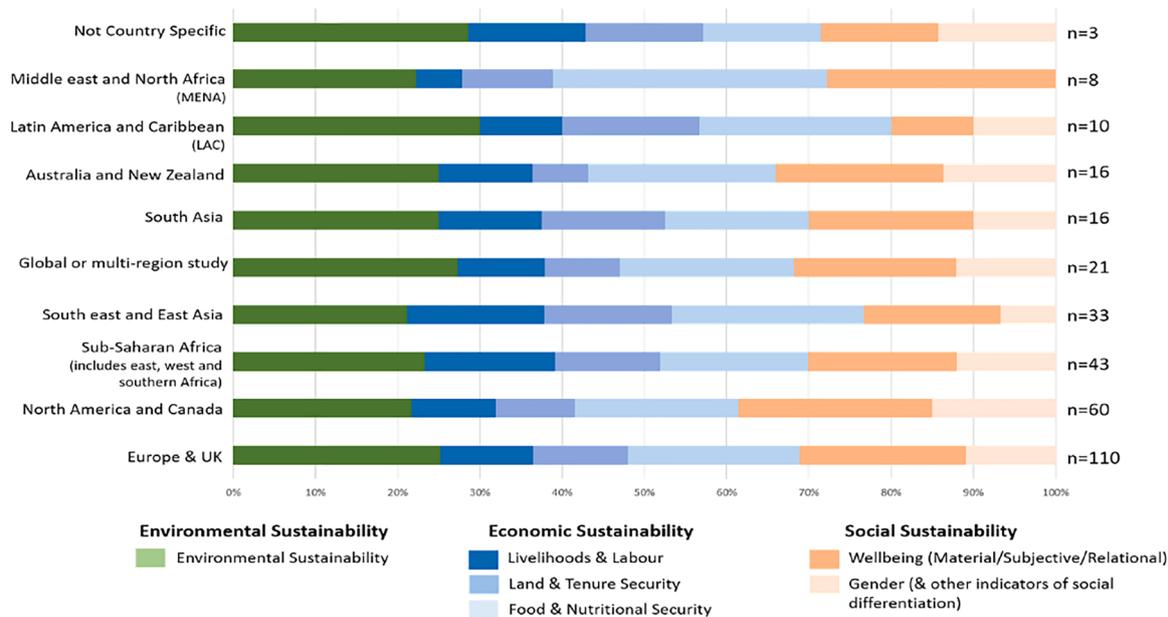


Fig. 6. Regional distribution of themes.

Table 4
Impacts on Sustainability Pillars (n = 320).

Sustainability Pillar	No impact mentioned (score 0)	Positive impact (score 1)	Negative impact (score -1)
Economic	190	112	18
Environmental	152	151	17
Social	146	160	14

2021). In Italy, while community-supported agriculture is offering full-time and part-time job opportunities, in some cases these jobs were reported to be low-wage and temporary in nature (Medici et al., 2021). Thus, the complex and multi-pronged implications of different models of UPA for the economy and people’s livelihoods is evident. An emerging discussion relates to the decommmodification of labour or use of volunteer labour rather than paid workers in sustaining UPA projects (Prové et al., 2018; Poulsen, 2017; Bahers & Giacchè, 2019; Pungas, 2019).

3.2.3. Land tenure and urban planning

Land and tenure security finds mention in only 23 of the 86 selected papers, most of them in Sub-Saharan Africa (de Oliveira & Ahmed, 2021; Abdulkadir et al., 2012; Khumalo & Sibanda, 2019; Olivier, 2019; Robineau & Dugue, 2018; Drechsel & Dongus, 2010).

The focus on land and tenure insecurity in middle and low-income countries can be explained by the relatively weak legal and institutional frameworks in relation to land administration in the global south (de Oliveira & Ahmed, 2021; Abdulkadir et al., 2012), with a large number of farmers farming on public land with limited guarantee for continuity (Abdulkadir et al., 2012; Hammelman, 2021). Land reforms and changing policies often lead to mistrust and lack of confidence, pushing farmers to avoid investing in their farms and sometimes selling their plots in anticipation of expropriation (Abdulkadir et al., 2012; Robineau & Dugue, 2018). In Zambia, urban farming is considered illegal because land use planning does not permit mixed use or agriculture within urban zones (Drechsel & Dongus, 2010), a problem experienced in many southern cities. Despite the high number of urban households practising UPA in the Global South (Abdulkadir et al., 2012), informality and tenure insecurity threatens its sustainability and draws attention to the need for formally incorporating UPA into urban development plans.

Interestingly, in some cases state authorities see urban farmers guarding lands against expansive development and encroachment by informal settlers’ and hence, support urban agriculture through informal and sometimes formal agreements (de Oliveira & Ahmed, 2021:4). In Rosario, Argentina the municipality institutionalized UPA practice on occupied land by allocating specific plots of marginalized land, i.e. land seen as undevelopable or at risk of flooding, for the purpose. Ironically, this offered a degree of tenure security (Hammelman, 2021). Such practices however appear to be more the exception than the rule.

In Europe, UK, North America and Canada, tenure insecurity is less of a concern because of well-defined land governance and formal agreements between UPA communities and municipalities, private landowners, and/or other organizations (Partalidou & Anthopoulou, 2017; Petrovica et al., 2019; Gasperi et al., 2016). Focus in these regions is often on availability and access to land in hyper-urbanized cities, covering issues of innovation and technology use; overcoming space constraints through terrace/vertical farming, or using waste as a growing medium (Jürkenbeck et al., 2019; Grard et al., 2015; Edmondson et al., 2020). Diehl et al. (2020) discuss Singapore’s policy innovations to foster high tech, landless urban farming, and co-locating urban farms on non-agricultural land to ensure self-sufficiency despite land availability limitations.

Few papers discuss insecurities related to land tenure in the Global North, as many farmers continue to practice UPA on rented, abandoned, or temporarily donated land, which remain under constant pressure of urban development (Pirro & Anguelovski, 2017; Petrovic et al., 2019; Grădinaru, 2018). One of the few exceptions is the Parisian study highlighting the relationship between land security and UPA project longevity, as long-term planning and investments are difficult when land tenure is uncertain (Prové et al., 2018).

3.2.4. Food and nutritional security

Twenty-nine of the 86 papers focused on food and nutritional security through UPA. While in a few papers, food production was identified to be one of the main drivers of UPA (Kingsley, Foenander, & Bailey, 2019; Partalidou & Anthopoulou, 2017; Mead et al., 2021), in others, food and nutritional security along with diet diversity were emphasized (Gasperi et al., 2016; Krisker et al., 2016; Olivier & Heinecken, 2017; Dobson et al., 2021).

In Melbourne, Australia, growing fresh food, being sustainable, and connecting with nature are major drivers of urban community gardens

Table A1
Description of criteria used for quality assessment.

Scoring criteria	Description/Definition	Score
Acknowledges existing research	Does the article include a literature review and/or does it recognise existing research?	Score 1 or 0
Conceptual framework	Does the article include a conceptual framework as part of their analysis?	Score 1 or 0
Research question/hypothesis	Does the article include a research question and/or hypothesis?	Score 0 or 1
Recognise limitations	Does the author(s) recognise and/or provide an explanation for any limitations to their research?	Score 0 or 1
Identified research method	Does the article identify their research method and if so, do they include a discussion on the methods used, including some level of detailed analysis such as a sample size?	Score 0 = no research method Score 1 = research method used but not explained Score 2 = research method used, including detailed analysis
Reason for design/method	Does the author(s) include an explanation and/or reason for why their study choose their research design/method?	Score 0 or 1
Well suited quantitative or qualitative indicators	Does the article include relevant and well-suited indicators for the sustainability and wellbeing outcomes of UPA and/or GI?	Score 0 = paper only includes anecdotal data Score 1 = paper has mentioned one or more sustainability indicators Score 2 = paper has defined and used indicators consistently throughout article
Outline results that are generalisable	Can the article's research results be broadly applied across different contexts (geographically and conceptually), including to urban sustainability outcomes?	Score 0 or 1
Logical conclusion	Does the article include a logical conclusion?	Score 0 or 1

(Kingsley, Foenander, & Bailey, 2019), with co-benefits of reduced food miles, and providing seasonal and tastier food. De-commodification of food by allotment gardens in Russia (Pungas, 2019) and reduction in the metabolic rift between ecology and society by developing alternative food networks in Australia (Canal Vieira et al., 2021), are also reported. Similar findings resonated in other cities of the Global North, including the UK, where urban land use for ‘allotments’ potentially contributes over 2% of the fruit and vegetable diets of urban inhabitants (Dobson et al., 2021) and Estonia, where farmers noted that 30–90% of their annual fruit and vegetable demands are met by their own farm-produce (Pungas, 2019). Although the contribution at times may seem small, its significance for food security of the most disadvantaged and those in extreme food poverty is critical (Gasperi et al., 2016).

Highlighting the potential of re-appropriating vacant or abandoned spaces within the city to produce food and build communities in Bologna (Italy), Gasperi et al. (2016:15) noted: “The engagement in the garden is a way to improve the food security of disadvantaged social groups who deal with limitations in accessing affordable healthy food and decrease the risk of creating “food deserts” in the suburbs and marginalized areas of cities”. Recent COVID-19 challenges to accessing food, especially amongst vulnerable communities, revealed differential fruit and vegetable consumption between men and women in households practising UPA in South African cities (Nchanji & Lutomia, 2021). In Cape Town, UPA not only made fresh and nutritious food available but also curtailed processed food consumption, thereby reducing health risks (Olivier, 2019).

Table A2
Description of non-score-based thematic categories.

Non-score-based categories	Description/Definition
Year	Year of publication
Region	Region of study
Keywords	Keywords of article
Type of research method	Quantitative, qualitative, spatial, mixed and unclear/not mentioned (mark 1 or 0)
Impact of UPA on the sustainability pillars	Indicate whether the article describes a positive (mark 1) or negative impact (mark -1) on one or more of the sustainability pillars: (1) environmental, (2) economic and (3) societal, or if the papers do not mention UPA's impact (mark 0)
Location of UPA	Urban (mark 1), peri-urban (mark 2) or both (mark 3)
Type of UPA	Private open space (mark 1); Rooftop/terrace/balcony (mark 2); Vertical gardening (mark 3); Greenhouses (mark 4); Other (mark 5); Formal allotments (mark 6); Encroached common spaces (mark 7)
Purpose of UPA	Personal consumption; additional income; market integrated; other; not mentioned (mark 1 or 0)
Themes	Environmental sustainability; Material wellbeing; Labour and livelihoods; Food and nutritional security; Gender and of social differentiation; Land tenure and urban planning; Scalability (mark 1 or 0 if theme isn't mentioned)

Table A3
Definition of UPA types.

Type of UPA	Description/Definition
Private open space	Privately owned land, for example a backyard, private garden and/or privately-owned agricultural land
Rooftop, terrace and balcony	Any form of agriculture that takes place in and on buildings
Vertical gardening	Any form of agriculture that takes advantage of vertical spaces as a means to support the growth of vegetables, flowers and herbs. This may include any stackable planting systems and/or wall re-greening
Greenhouses	A self-contained structure made from a transparent material, used to provide a regulated climate for the growth of plants and vegetables
Formal allotments	Allotted land formally owned by a municipality for the purpose of non-commercial agricultural production
Encroached common spaces	Informal spaces which have been encroached upon for the purpose of agricultural activities

Community gardeners in Seville, Spain demonstrated how ‘organic food’ can be operationalised in terms of being healthier and fostering values of collective solidarity (Jordi-Sánchez and Díaz-Aguilar, 2021). Similar findings resonated from the UK where linkages between UPA and enhanced diet quality are indirect and mostly via health, ethical, and food choice motivations (Mead et al., 2021). In Berlin, Germany, the idea of “biodiverse edible schools” helped improve children’s understanding of food production, apart from bolstering diets, promoting environmental awareness in children, and supporting cultural and provisioning ecosystem services in cities (Fischer et al., 2019). UPA enhanced urban resilience with co-benefits of food sovereignty and shorter production-consumption chains in Chile (Delpino-Chamy et al., 2019) and by supplying quality food by re-appropriating urban waste in France (Grand, 2015).

In the Global South, while UPA activities remain largely informal, they contribute significantly to food and nutritional security

Table A4

List of 86 articles shortlisted for qualitative analysis.

ID	Year	Title	Author	Journal	Country
1	2012	Characterisation of Urban and peri-urban agroecosystems in three West-African cities	Abdulkadir, et al.	Intl J of Agril Sust	West Africa
2	2020	Urban agri and land use in cities – an approach with the multi-functionality and sustainability concepts in the case of Antananarivo (Madagascar)	Aubry, et al.	Land Use Policy	Madagascar
3	2018	Towards a metabolic rift analysis: the case of urban agriculture and organic waste management in Rennes (France)	Jean-Baptiste and Giacche	Geoforum	France
4	2015	Perceptions and contributions of households towards sustainable urban green infrastructure in Malaysia	Barau, A. S.	Habitat International	Malaysia
5	2003	Water, land and health in urban and peri-urban food production: the case of Kano, Nigeria	Binns, et al.	Land Degradation and Development	Nigeria
6	2018	Sleeper cells for urban green infrastructure: harnessing latent competence in greening Dhaka's slums	Birtchnell, et al.	Urban Forestry and Urban Greening	Bangladesh
7	2017	Expanding the Social performance of food production landscapes: measuring health and wellbeing benefits	Burke E.	Landscape research	Global
8	2016	Ecosystem services provided by urban gardens in Barcelona, Spain: Insights for policy and planning	Camps-Calvet, et al.	Environmental Science and Policy	Spain
9	2019	Local Scale Prioritisation of Green Infrastructure for Enhancing Biodiversity in Peri-Urban Agroecosystems: A Multi-Step Process Applied in the Metropolitan City of Rome (Italy)	Capotorti, et al.	Sustainability	Italy
10	2019	The socio-environmental impacts of public urban fruit trees: A Montreal case-study	Colinas, et al.	Urban Forestry & Urban Greening	Canada
11	2019	Methodology to identify and assess agroecological practices in metropolitan areas – case study of Concepcion, Chile	Delpino-Chamy, et al.	Intl J of Design & Nature and Ecodynamics	Chile
12	2019	Pathways of learning about biodiversity and sustainability in private urban gardens	Diduck, et al.	Journal of Environmental Planning and Management	Canada
13	2016	Cultivating citizenship, equity, and social inclusion? Putting civic agriculture into practice through urban farming	Poulsen M.N.	Agriculture and Human Values	United States of America
14	2019	Politics of scale in urban agriculture governance: A transatlantic comparison of food policy councils	Prové, et al.	Journal of Rural Studies	Belgium and United States of America
15	2018	The modus operandi of urban agriculture initiatives: Toward a conceptual framework	Prové, et al.	Nature and Culture	Global
16	2019	Food self-provisioning as an answer to the metabolic rift: case of "Dacha Resilience" in Estonia	Pungas L.	Journal of Rural Studies	Estonia
17	2018	A socio-geographical approach to the diversity of urban agriculture in a West African city	Robineau and Dugué	Landscape and Urban Planning	West Africa
18	2018	Social sustainability through social interaction – A national survey on community gardens in Germany	Rogge, et al.	Sustainability	Germany
19	2016	Resolving differing stakeholder perceptions of urban rooftop farming in Mediterranean cities: promoting food production as a driver for innovative forms of urban agriculture	Sanye, et al.	Agriculture Human Values	Spain
20	2020	Understanding climate gentrification and shifting landscapes of protection and vulnerability in green resilient Philadelphia	Shokry, et al.	Urban Climate	United States of America
21	2018	Urban agriculture, dietary diversity and child health in a sample of Tanzanian town folk	Wagner and Tasciotti	Canadian Journal of Development Studies	Tanzania (East Africa)
22	2020	The potential of urban agriculture in combination with organic waste valorization: Assessment of resource flows and emissions for two European cities	Weidner and Yang	Journal of Cleaner Production	Scotland and France
23	2010	Dynamics and sustainability of urban agriculture: examples from sub-Saharan Africa	Drechsel and Dongus	Sustainability Science	Sub-Saharan Africa
24	2019	Biodiverse edible schools: Linking healthy food, school gardens and local urban biodiversity	Fischer, et al.	Urban Forestry and Urban Greening	Germany
25	2016	Towards regenerated and productive vacant areas through urban horticulture: Lessons from Bologna, Italy	Gasperi, et al.	Sustainability	Italy
26	2015	Assessment of social-ecological transitions in a peri-urban Ethiopian farming community	Gilioli, et al.	International Journal of Agricultural Sustainability	Ethiopia
27	2018	Contribution of agricultural activities to urban sustainability: Insights from pastoral practices in Bucharest and its peri-urban area	Grădinaru, et al.	Habitat International	Romania
28	2015	Recycling urban waste as possible use for rooftop vegetable gardens	Grard, et al.	Future of Food: Journal on Food, Agriculture and Society	France
29	2017	Relationship between Consumer Behaviour and Success of Urban Agriculture	Grebitus, et al.	Ecological Economics	United States of America
30	2015	Greener growing: assessing the influence of gardening Practices on the ecological viability of community gardens in South East Queensland, Australia	Guitart, et al.	Journal of Environmental Planning and Management	Australia
31	2019	Sustainability matters: Consumer acceptance of different vertical farming systems	Jürkenbeck, et al.	Sustainability	Germany
32	2019	Urban agriculture as a source of social capital in the Cape Flats of Cape Town	Kanosvamaha, et al.	African Geographical Review	South Africa
33	2019	Does urban and peri-urban agriculture contribute to household food security? An assessment of the food security status of households in Tongaat, eThekweni Municipality	Khumalo and Sibanda	Sustainability (Switzerland)	South Africa
34	2019	"You feel like you're part of something bigger": exploring motivations for community garden participation in Melbourne, Australia	Kingsley, et al.	BMC Public Health	Australia
35	2019	Socio-economic viability of urban agriculture - A comparative analysis of success factors in Germany	Krikser, et al.	Sustainability	Germany
36	2015		Lee, et al.	Landscape and Urban Planning	Korea

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Table A4 (continued)

ID	Year	Title	Author	Journal	Country
		Greenhouse gas emission reduction effect in the Transportation sector by urban agriculture in Seoul, Korea			
37	2019	Gardens and Green Spaces: placemaking and Black entrepreneurialism in Cleveland, Ohio	Lindemann G.	Agriculture and Human Values	United States of America
38	2000	Urban agriculture in Mexico City: Functions provided by the use of space for dairy based livelihoods	Losada, et al.	CITIES	Mexico
39	2017	Enhancing urban agriculture through participants' satisfaction: The case of Seoul, Korea	Oh and Kim	Land Use Policy	Korea
40	2019	Urban agriculture promotes sustainable livelihoods in Cape Town	Olivier D.W.	Development Southern Africa	South Africa
41	2016	The personal and social benefits of urban agriculture experienced by cultivators on the Cape Flats	Olivier and Heinecken	Development Southern Africa	South Africa
42	2016	Urban Allotment Gardens During Precarious Times: From Motives to Lived Experiences	Partalidou, et al.	Sociologia Ruralis	Greece
43	2018	Environmental and social dimensions of community gardens in East Harlem	Petrovica, et al.	Landscape and Urban Planning	United States of America
44	2017	Farming the urban fringes of Barcelona: Competing visions of nature and the contestation of a partial sustainability fix	Pirro and Anguelovskib	Geoforum	Spain
45	2019	Farm Diversification and Sustainability of Multifunctional Peri-Urban Agriculture: Entrepreneurial Attributes of Advanced Diversification in Japan	Yoshida, et al.	Sustainability	Japan
46	2020	Home gardening practice in Pune (India), the role of communities, urban environment and the contribution to urban sustainability	Zasada, et al.	Urban Ecosystems	India
47	2021	Incorporating user preferences in rooftop food-energy-water production through integrated sustainability assessment (*)	Toboso-Chavero, et al.	Environmental Research Communications	Spain
48	2021	Is urban growing of fruit and vegetables associated with better diet quality and what mediates this relationship? Evidence from a cross-sectional survey	Mead, et al.	Appetite	United Kingdom
49	2021	Life cycle assessment of a circular, urban mushroom farm	Dorr, et al.	Journal of Cleaner Production	France
50	2021	Monitoring the contribution of urban agriculture to urban sustainability: an indicator-based framework	Tapia, et al.	Sustainable Cities and Society	Denmark
51	2021	Alternative Agri-Food Systems under a Market Agencements Approach: The Case of Multifunctional Farming Activity in a Peri-Urban Area	Mancini, et al.	Environments	Italy
52	2021	Alternative Food Networks in Food System Transition-Values, Motivation, and Capacity Building amongst Young Swedish Market Gardeners	Drottberger, et al.	Sustainability	Sweden
53	2021	Article prospects for rooftop farming system dynamics: An action to stimulate water-energy-food nexus synergies toward green cities of tomorrow	Huang and Chang	Sustainability	Taiwan
54	2021	Assembling agroecological socio-natures: a political ecology analysis of urban and peri-urban agriculture in Rosario, Argentina	Hammelman, et al.	Agriculture and Human Values	Argentina
55	2021	Building resilient cities with stringent pollution controls: A case study of robust planning of Shenzhen City's urban agriculture system	Zhou, et al.	Journal of Cleaner Production	China
56	2021	Combining LCA and circularity assessments in complex production systems: the case of urban agriculture	Martí Ruff-Salis	Resources, Conservation and Recycling	Spain
57	2021	Comparative analysis of carbon footprint between conventional smallholder operation and innovative large scale farming of urban agriculture in Beijing, China	Hu, et al.	Peerj	China
58	2021	Constructing organic food through urban agriculture, community gardens in Seville	Jordi-Sánchez, et al.	Sustainability (Switzerland)	Spain
59	2021	COVID-19 challenges to sustainable food production and consumption: Future lessons for food systems in eastern and southern Africa from a gender lens	Nchanji & Lutomia	Sustainable Production and Consumption	Africa
60	2021	Daring to build fair and sustainable urban food systems: A case study of alternative food networks in Australia	Vieira, et al.	Agroecology and Sustainable Food Systems	Australia
61	2021	Differences in motivations and social impacts across urban agriculture types: Case studies in Europe and the US	Rositsa, et al.	Landscape and Urban Planning	Europe and United States of America
62	2021	Exploring the economic, social, and environmental dimensions of community-supported agriculture in Italy	Medici, et al.	Journal of Cleaner Production	Italy
63	2020	Systemic design for food self-sufficiency in urban areas	Núñez-Ríos, et al.	Sustainability (Switzerland)	Global
64	2020	The role of edible cities supporting sustainability transformation - A conceptual multi-dimensional framework tested on a case study in Germany	Artmann, et al.	Journal of Cleaner Production	Germany
65	2021	A sustainable approach for urban farming based on city logistics concepts for local production and consumption of vegetables	de Oliveira, et al.	Research in Transportation Economics	Brazil
66	2021	Forecasting agroforestry ecosystem services provision in urban regeneration projects: Experiences and perspectives from milan	Zanzi, et al.	Sustainability (Switzerland)	Italy
67	2021	Goals and persistence of sustainability experiments in divergent urban contexts: urban agriculture and a geodemographic classification in London	Håkansson I.	Local Environment	United Kingdom
68	2021	Governance of urban agriculture in African cities: Gaps and opportunities for innovation in Accra, Ghana	de Oliveira and Ahmed	Journal of Cleaner Production	Ghana
69	2021	Growing pains: Small-scale farmer responses to an urban rooftop farming and online marketplace enterprise in Montreal, Canada	Allaby, et al.	Agriculture and Human Values	Canada
70	2021	Heavy metal accumulation and genotoxic effect of long-term wastewater irrigated peri-urban agricultural soils in semiarid climate	Oubane, et al.	Science of the Total Environment	Marrakesh
71	2021	Impacts of agricultural land acquisition for urbanization on agricultural activities of affected households: A case study in huong thuy town, thua thien hue province, vietnam	Thi, et al.	Sustainability (Switzerland)	Vietnam
72	2021	Implementation of urban green infrastructures in peri-urban areas: A case study of climate change mitigation in madrid	Gómez-Villarino, et al.	Agronomy	Spain
73	2020	Ecosystem services of urban agriculture: Perceptions of project leaders, stakeholders and the general public	Sanyé-Mengual, et al.	Sustainability (Switzerland)	Italy
74	2020				Germany

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Table A4 (continued)

ID	Year	Title	Author	Journal	Country
75	2020	Edible cities - An innovative nature-based solution for urban sustainability transformation? An explorative study of urban food production in German cities	Sartison and Artmann	Urban Forestry & Urban Greening	Italy
76	2020	Edible green infrastructure for urban regeneration and food security: Case studies from the campania region	Russo and Cirella	Agriculture (Switzerland)	Italy
77	2020	Environmental and economic life cycle assessment of alternative greenhouse vegetable production farms in peri-urban Beijing, China	Zhen, et al.	Journal of Cleaner Production	China
78	2020	Feeding a city - Leicester as a case study of the importance of allotments for horticultural production in the UK	Edmondson, et al.	Science of the Total Environment	United Kingdom
79	2020	Feeding cities: Singapore's approach to land use planning for urban agriculture	Diehl, et al.	Global Food Security Sustainability (Switzerland)	Singapore
80	2020	Formalizing objectives and criteria for urban agriculture sustainability with a participatory approach	Clerino, et al.		France
81	2020	Governing urban gardens for resilient cities: Examining the 'Garden City Initiative' in Taipei	Hou, et al.	Urban Studies	Taiwan
82	2020	Green roof effects on daytime heat in a prefabricated residential neighbourhood in Berlin, Germany	Knaus & Haase	Urban Forestry and Urban Greening	Germany
83	2020	Growing together: Community coalescence and the social dimensions of urban sustainability	Glennie C.	Sustainability (Switzerland)	United States of America
84	2020	Guidelines for urban community gardening: Proposal of preliminary indicators for several ecosystem services (Rome, Italy)	Caneva, et al.	Urban Forestry and Urban Greening	Italy
85	2020	Management of slum-based urban farming and economic empowerment of the community of Makassar City, South Sulawesi, Indonesia	Surya, et al.	Sustainability (Switzerland)	Indonesia
86	2020	Perceptions of the challenges and opportunities of utilising organic waste through urban agriculture in the durban south basin	Menyuka, et al.	Journal of Environmental Research and Public Health	South Africa
86	2020	Productivity, resource efficiency and financial savings: An investigation of the current capabilities and potential of South Australian home food gardens	Csortan, et al.	PLoS ONE	Australia

(Abdulkadir et al., 2012). In Tanzania, practising UPA and/or livestock keeping led to consuming more diverse diets and improved health of urban children (Wagner and Tasciotti, 2018). In Madagascar, food production for consumption and sale was a major motivation of UPA (Aubry et al., 2012). In Thekwini Municipality, Durban, South Africa, UPA practising households reported having higher food access and were less likely to have diet sensitive chronic diseases resulting from food insecurity such as obesity amongst both adults and children than non-UPA practising households (Khumalo & Sibanda, 2019). In a review of literature, Burke (2017) concludes that food growing gardeners and households have a higher consumption of fruits and vegetables and tend to practice better eating habits leading to beneficial health outcomes. Savings on healthcare bills and uncompromised labour productivity could enhance household material wellbeing.

3.2.5. Subjective and relational wellbeing

The relationship between UPA and wellbeing outcomes at different scales – the individual, household, and community – is well established. Nearly half, i.e. 41 out of the 86 papers focus on one or more aspects of wellbeing

Several studies discuss how UPA enhances social or relational wellbeing, through improved social inclusion and cohesion, increased solidarity, larger social networks, and community building (Pungas, 2019; Burke, 2017; Camps-Calvet et al., 2016; Poulsen, 2017; Gasperi et al., 2016; Kanosvamhira & Tevera, 2020; Tapia et al., 2021; Medici et al., 2021). For example, a study on urban gardens in Barcelona highlights their valuable role in providing 'cultural services' of individual and societal importance, especially for low-income groups, even more than 'provisioning' or 'regulating' ecosystem services (Camps-Calvet et al., 2016). Community farms and urban gardens as spaces for community engagement and social interaction are highlighted across several studies (Poulsen, 2017; Lindemann, 2019; Rogge et al., 2018; Kingsley, Foender, & Bailey, 2019; Hakansson, 2021). They also foster inter-generational ties, becoming "an intergenerational meeting point for elderly and young people, where traditional and intercultural knowledge (e.g., crop biodiversity, food preparation recipes) was exchanged" (Gasperi et al., 2016: 11). On similar lines, Grădinaru et al. (2018) highlight how pastoral practices in Bucharest and its peri-urban areas helped in maintaining important cultural and family traditions.

In her study on Food Self Provisioning (FSP) in Estonia, Pungas (2019:83) found that respondents reported better relations with

neighbours, highlighting aspects of trust, helping nature and general camaraderie, leading to FSP becoming "not only a sufficiency economy, but also operates as a moral economy of mutual aid". The contribution of urban agriculture to building and expanding social capital and social connections is noted across studies (Kanosvamhira & Tevera, 2020; Olivier, 2019; Colinas et al., 2019).

Several papers point to the positive subjective wellbeing outcomes of UPA such as providing opportunities for relaxation and reduction in stress, entertainment and leisure, exercise and physical recreation, increasing a sense of happiness and satisfaction, improved quality of life, and sense of pride (Kingsley, Foender, & Bailey, 2019; Khumalo et al., 2019; Xie et al., 2020). Camps-Calvet et al. (2016: 7) further stress this aspect at a city scale, noting "The role of gardens as non-consumptive spaces of leisure can be especially important for cities ridden by gentrification and privatization of public space where access to leisure activities is increasingly commodified and restricted to those lacking sufficient purchase power". There are other benefits too. The experience of 'active leisure' through "the gardening process: by labouring the soil, sowing seeds, planting, weeding, harvesting and preparing food" and being able to enjoy one's "fruits of labour" (Pungas, 2019: 83) significantly contribute to subjective wellbeing. Others include the opportunity to exercise and be involved in physical activity leading to a healthy lifestyle (Burke, 2017) or reconnecting to one's rural past in an urban setting through urban agricultural parks, as in the case of China, where the majority urban population come from rural areas (Xie et al., 2020).

UPA activities contributing to enhanced mental health and satisfaction of participants is a dominant finding across multiple papers. In assessing the contribution of 'food production landscapes' to health and wellbeing, a number of mental wellbeing benefits are noted such as a 'sense of purpose', 'relaxing', 'forgetting worries while gardening', 'emotional processing', 'stress release', 'a form of therapy' and 'recovery of focus' (Burke, 2017). In fact, mental wellbeing is seen as one of the dominant motivations for practising UPA and as one male respondent noted, "I have been unemployed for some time now and for me the garden is something that keeps me going, something that drives me out of the house! Otherwise, I would be all day in front of the TV, depressed and isolated. But in the garden, I also found a place to meet other people like me, to share our fears, our thoughts for the future" (Partalidou & Anthopoulou, 2017:11). Furthermore, a sense of connection, satisfaction, accomplishment and pride as growers is associated with gardening activities (Pertovica et al., 2018; Olivier & Heinecken, 2017; Tapia et al., 2021).

Table A5
Synthesis of positive and negative environmental outcomes of urban and peri-urban agriculture.

	Positive outcomes	Negative outcomes
Global North	<p>Composting (in private and community gardens) helps in shorten the nutrient cycle (Bahers & Giacchè 2018, France); rooftop gardens using local urban organic waste can help handle urban waste sustainably (Grard et al., 2015; Canal Vieira et al., 2021, Brisbane and Melbourne)</p> <p>Species diversity in wild edible gardens (Fischer et al., 2019); conservation of heritage plants including seed saving, swapping seeds/plants between members, and using organic seed/seedling providers (Guitart et al., 2015, Southeast Queensland; Zanzi, 2021 in Milan); counteracts farmland biodiversity loss, can improve ecological connectivity (Capotorti et al., 2019, Rome)</p> <p>Environmentally sustainable practices such as composting, permaculture, rainwater harvesting (Diduck et al., 2019, Winnipeg; Camps-Calvet et al., 2016, Barcelona; Huang and Chang, 2021, Taipei); waste recycling (Dorr et al., 2021, Paris); higher environmental awareness amongst farmers; can incentivise environmentally sensitive urban planning (Capotorti et al., 2019, Rome; Clerino et al., 2020, France; Sartison & Artmann 2020, Germany)</p> <p>Climate mitigation co-benefits such as GHG emission reductions by direct carbon uptake (Gómez-Villarino et al., 2021; Hu, Sun, & Zheng, 2021, China), reducing the need for temperature control in buildings and lower food miles (Lee et al., 2015, Seoul; Knaus & Haas, 2020 in Berlin)</p> <p>Strengthens ecosystem services including erosion control, flood protection, pollinator support, soil fertility regulation, water quality regulation (Capotorti et al., 2019, Rome; Camps-Calvet et al., 2016, Barcelona).</p>	<p>Unequal environmental benefits for the wealthier – spatially and historically shaped inequality is overlaid on UA practices (Shokry et al., 2020, Philadelphia)</p> <p>Trade-offs between high food production (e.g. through greenhouse) and socio-ecological sustainability (e.g. effluents or public desirability) (Weidner & Yang, 2020, Glasgow and Lyon)</p> <p>Pastoral activities usually have a positive impact on social and economic sustainability but can entail environmental conflicts between urban residents and livestock rearers on account of smell, looks, waste management (Grădinaru, 2018, Bucharest)</p>
Global South	<p>Integration of subsistence livestock rearing in UPA helps maintain soil fertility and enable nutrient cycling (Abdulkadira et al., 2012 in Kano, Nigeria, Bobo Dioulasso, Burkina Faso and Sikasso, Mali; Pungas, 2019, Estonia; Menyuka et al., 2020 in Durban); increases soil fertility and nutrient cycling, protects biodiversity and reduces waste and pollution, (Abdulkadira et al., 2012)</p> <p>Shortens production-consumption chains, with benefits for SDG12; enhanced species diversity and protection of flora and fauna (Delpino-Chamy et al., 2019, Concepción, Chile; Zasada et al., 2020, Pune)</p> <p>Absorption of floodwater where urban farmlands act as buffer zones, preventing/limiting flooding in</p>	<p>Water contamination due to agricultural chemicals coupled with poor landfill and sewage management can enhance disease (Binns et al. 2013 in Kano, Nigeria); negative downstream impacts (e.g., higher water pollution due to intense paddy cultivation) (Aubry et al., 2012, in Antananarivo, Madagascar; Zhou et al., 2021, China)</p> <p>Excessive inputs increase land productivity but with environmental tradeoffs (Dreschel, 2010, in Kumasi, Ghana), especially when industrial fertilizers are used. With frequent irrigation this leads to nutrient depletion (through harvest and leaching) and instant</p>

Table A5 (continued)

Positive outcomes	Negative outcomes
<p>slums (Aubry et al., 2012, Antananarivo, Madagascar)</p> <p>Ecosystem restoration with long-term farming transforming barren land and improving food production, water holding capacity, biodiversity (Gilioli, 2015, peri-urban Addis Ababa).</p> <p>Environmentally sensitive urban planning through allowing flexibility for trade-offs between pollution control and economic development (Zhou et al., 2021, China)</p>	<p>replenishment (through manure/fertilizer and partly wastewater irrigation) resulting in the accumulation of poorly leached phosphorous and temporary depletion of nitrogen and potassium (Drechsel et al. 2005).</p> <p>Unintended health impacts: uncontrolled and long-term irrigation by wastewater leads to human health and environmental damages (Oubane et al., 2021, Marrakesh)</p>

While the overall evidence on wellbeing outcomes of UPA are mostly positive, Gilioli et al. (2015) demonstrate in their study in a peri-urban farming community in Ethiopia, that such outcomes of UPA are dynamic and take longer time to accrue and become visible.

3.2.6. Gender and social differentiation

Social equity is a central pillar of sustainable development, alongside livelihood security and environmental sustainability, hence gender equality and wider social inequalities feature as independent Sustainable Development Goals 5 and 10 respectively. Yet, only 19 of the 86 papers reviewed in-depth discuss issues of gender and wider social difference in examining the implications of UPA. Interestingly, while race and class feature in the papers from the Global North (11 papers), gender is prominent in those from the Global South, both sub-Saharan Africa and Asia (8), pointing perhaps to the feminization of agriculture in contexts where farming remains an important, though often low-paid livelihood activity.

Several papers point to the role of social inclusion, particularly by class/wealth and racial identities, in mediating differential outcomes of UPA in terms of access to good quality food or income and employment benefits (Poulsen, 2017, Prové et al., 2018, Shokry et al., 2020). They suggest that disadvantaged groups and racial minorities are often excluded from the benefits of UPA, unless interventions are specifically designed for them (Dobson et al., 2021; Lindemann, 2019). Hakansson (2021) emphasizes the need to recognize intra-urban differences in demographics, education, access to resources and infrastructures across neighbourhoods, and the ways in which affluence or deprivation shape engagement with UPA. While sustainability is often framed in ecological or economic terms, in low-income neighbourhoods, and those with ethnic minorities, they find the need to transform ‘urban spaces of neglect’ into community resources, spaces for cultural exchange and provision of amenities, especially for women, youth and the homeless, a key driving force (ibid: 746). Prové et al. find that while generally enthusiastic about the recreational and social aspects of UPA, their interviewees also expressed concerns about the “exclusion of groups of people where activities or access are not free or are not explicitly directed toward disadvantaged groups” (2018: 26). A similar finding emerges from Poulsen’s (2017) study in Baltimore, where the commercial farm created jobs for low-income youth, but to enhance profits, the food grown was sold in wealthier localities.

What this suggests is that outcomes vary for different groups of people. Shokry et al. in Philadelphia suggest that inequalities might have been enhanced by the creation of new urban landscapes, what they refer to as “risksapes in which low-income and minority residents were shifted into conditions of heightened socio-ecological insecurity” (2020: 17). They note that the benefits of protective infrastructure have gone to areas with wealthier, whiter and better educated residents over time. Glennie (2020) makes a similar point about green spaces leading to rise in property prices and gentrification, with implications for growing inequalities within cities. Kirby et al. (2021:7) therefore emphasize the

importance of considering the role of the participant, with owners and operators having a higher level of wellbeing than employees in commercial farms.

While a focus on social development, or community participation, doesn't lead automatically to social justice or food justice in terms of equitable access to fresh local food for all consumers/residents alongside enhanced farmer incomes (Prové et al., 2018; Mancini et al., 2021; Poulsen, 2017), it is important to note that community building and cohesion in itself is also a worthwhile sustainability objective, especially in contexts where immigrants, elderly, the young, are increasingly isolated and excluded from decision-making processes or even social support networks (Glennie, 2020). Examining inclusion and exclusion through a scalar lens, Prové et al. (2019) find the potential for local Food Policy Councils to pay attention to context specific inequalities higher than in city-level planning processes, which often adopt a more aggregated lens on the benefits accruing from UPA, a point also made by Hakansson (2021).

Unlike identities of class or race, gender is mainly referenced in terms of the demographic profiles of study respondents, such as 60% being women (Olivier, 2019) or a majority being middle aged and older women in the Cape flats (Olivier & Heineken, 2017), Italy (Mancini et al., 2021), or North America (Greibitus et al., 2017), or women being on the frontline in households practising UPA in Durban (Khumalo & Sibanda, 2019). Amongst the younger generation, women had a more positive attitude towards urban farms (Greibitus et al., 2017). Zanzi (2021) reports that where women are leaders in these interventions, they also give greater attention to gender equity, not however spelling out the mechanisms for doing so. In the context of high unemployment rates in Greece, however, Partalidou & Anthopoulos (2017) found that a majority of urban farmers were male, in their mid-40s and had families. This is one of the few papers that goes beyond noting the sex of the respondents, to examining the impacts of UPA on gender relations. As mentioned in section 3.2.5, for unemployed men here, any kind of work outside the home is seen as not just productive but also status-giving, countering the negative connotations of 'staying at home' (Ibid: 11).

Oh & Kim (2017) exploring the roles of different groups of people in UPA in Seoul, point to the special relationship between women's engagement with UPA and the adoption of sustainable practices. They find that most women consider urban agricultural activities a hobby, hence experiment with new practices and ideas, those seen as sustainable, and it is this perceived contribution that gives them a sense of satisfaction. Zasada et al. (2020: 412) while noting that the demographics of the home gardening community in Pune is "*clearly female, highly educated and of older age, with many gardeners retired from work,*" also point out that "*particularly in the cases where the gardener was female, the contribution to sustainability was higher nearly throughout all benefit types.*" Whether or not this is a stereotype of women as closer to nature and nurture (Ortner, 1974), however, needs to be explored through further research.

While inequalities emerging from class and race appear to be better analysed in the literature, especially in terms of the trade-offs between income and employment and good food and health, given that residential patterns are often spatially and socially differentiated, the insights around the contributions of UPA to shaping and transforming gender relations remain unclear. This could be for several reasons, ranging from the invisibility of agricultural work performed at home, work that is unpaid and seen as an extension of women's domestic duties, the construction of UPA as a 'hobby' rather than 'work', or the reinforcement of the nature-culture dualism in identifying sustainable UPA as a largely feminised activity.

4. Discussion

We began this paper with a question: 'What is the landscape of the UPA literature and what are the sustainability and wellbeing outcomes of UPA?' To answer this, we conducted a systematic literature review

and assessed 320 papers for the reported regional focus, types, and outcomes of UPA; alongside an in-depth, qualitative assessment of 86 papers focussing on six themes. In this section, we summarise our key findings. In the final conclusion section, we discuss briefly their policy relevance and highlight key takeaways from the literature on how UPA can be governed and scaled up to meet urban sustainability and wellbeing goals.

The literature reviewed, growing rapidly in the last decade, tends to still primarily focus on the Global North, and on urban rather than peri-urban areas. While papers almost always report multiple benefits of UPA, there were relatively few quantified assessments of UPA as an effective nature-based solution with co-benefits for social, economic and environmental sustainability, especially in the Global South.

The clearest evidence available relates to environmental sustainability, yet even in this dimension, there are few experimental studies and those that exist are city/crop-specific. In addition, the benefits of UPA are often anecdotal or presented in terms of stakeholder perceptions and therefore need further substantiation (Sanyé-Mengual et al., 2020; Jürkenbeck et al., 2019; Mancini et al., 2021). This gap undermines the possibility of quantitatively comparing the environmental outcomes of UPA and legitimises critiques that consider the evidence on UPA benefits to be of low quality, more so, when dealing with contentious issues such as land use. Together, this then becomes an excuse for policy inaction. As Aubry et al. (2012: 438) note, "Finally, the integration of urban agriculture into urban planning, a hot topic in developing countries and worldwide (Vandermeulen et al., 2006), is less a question of global land shortage in and around cities than one of political will and of adequate knowledge and methods – which, in turn, need the involvement of applied research." Despite arguments around the "multifunctionality" and "advanced diversification" of UPA practices, and the potential to improve the economic viability and continuity of commercial UPA (Yoshida et al., 2019), development pressures on urban and peri-urban land globally has led to negligible government support for UPA, significantly constraining scaling these practices (Petrovica et al., 2019; Pirro & Anguelovski, 2017; Diehl et al., 2020; Artmann & Sartison, 2018). While there is increasing support and demand for locally grown healthy food amongst the urban population, producers and consumers, specifically millennials who generally positively associate UPA with aspects related to society (community building, employment and incomes), environment (sustainability and resilience), and food (healthy, organic, fresh and ethical food) (Greibitus et al., 2017), such a view is conspicuously absent in the agriculture policies and urban planning of most countries. Links between UPA and food and nutrition security seem to be covering both human and environmental wellbeing, however, in the absence of quantification of the amount of food produced in urban areas and its nutritional benefits (e.g., through enhanced dietary diversity), or studies addressing concerns of food safety due to contamination/pollution of soil and water in urban areas, policy inaction persists.

Land tenure security, livelihoods, and labour are topics that need more research in both the Global North and the South, albeit for different reasons. In the context of the Global South, while critical as a livelihood activity, more focus is needed to explore how urban farmers can be supported through stronger legal and institutional frameworks that recognize and protect agriculture as a legitimate and valuable land-use option in cities. A key barrier to stronger government support for UPA is related to the fact that performance of UPA is often judged based on yield/productivity alone, more so in the Global South than in the Global North (Clerino & Fargue-Lelievre, 2020; Hakansson, 2021). UPA is then not seen as "real agriculture" by many stakeholders, especially planners/policy-makers, who see it as a social rather than productive activity, hindering, as in Spain, the uptake of urban agriculture as a component of municipal planning (Sanyé-Mengual, 2020).

In the Global North, as more UPA projects proliferate, some socially driven, while many entrepreneurially driven and technologically savvy, it is important to study their contribution to local livelihoods and

economic development in an equitable manner, alongside their well-being implications, particularly related to health and nutrition, at household, community, and city scales. In fact, in the desire to meet environmental goals, it is important not to forget the potential for unequal benefits, exclusion and even conflicts that could arise, as several papers caution.

The evidence on the wellbeing outcomes of UPA is strong and geographically diverse. Subjective and relational wellbeing outcomes seem to be predominant reasons for the uptake of and participation in UPA, especially in the Global North. However, there are few studies that provide quantitative assessment of the outcomes that can aid decision makers to mainstream UPA interventions in urban planning (Jürkenbeck et al., 2019). Also, while most studies highlight positive wellbeing outcomes of UPA, few papers touch upon what might be unintended consequences such as tensions between new UPA initiatives and older farming models or exclusion of certain groups of people from participating in UPA initiatives.

Apart from a comprehensive assessment of the multiple benefits of UPA, there are also knowledge gaps in terms of the diversity of stakeholders (e.g. producers and consumers belonging to different age, gender, class). Few studies focus on the impact of UPA on gender relations, especially across intersecting identities of race, class or employment status. Advances in gender studies clearly demonstrate the intersectional nature of social identity as shaping experiences of work and wellbeing. Given the large number of women participants reported in several studies, a more nuanced analysis could suggest strategies with gender equality co-benefits.

A common question around the outcomes and efficacy of UPA is on how these predominantly local and small-scale practices can be scaled up and sustained. Mobilizing political and government institutions for successful implementation and scaling of UPA (Hou, 2018) is crucial, however, there is some inhibition around state involvement and formalization of UPA (Hammelman, 2021). These range from fear of losing autonomy over local food systems, greater inequity in benefits, being pushed to marginal land, to the continued “temporary” nature of state support through finance and land allocation (Hammelman, 2021; de Oliveira & Ahmed, 2021; Prové et al., 2019). Hakensson (2021) indicates the need to think about institutionalization carefully as it may have differential implications for different socio-demographic communities living within cities, benefiting some and depriving others. Prové et al. (2018), discussing governance of UPA through Food Policy Councils (FPCs), emphasize the importance of broad-based representation from the government and civil society as contributing to the formation of “ideal governance platforms” for a sustainable local food system. Comparing the activities of FPCs to foster locally controlled food systems in Ghent (city-scale) and Philadelphia (neighbourhood scale), the authors show how the social construct of scale dictates what is considered local and who is included or excluded from such arrangements. As such, the paper emphasises procedural justice as a core objective of governance arrangements to ensure more equitable outcomes of any effort towards supporting UPA. UPA can incentivise urban and regional planning to be more sensitive to environmental concerns and ecosystem functioning (Capotorti et al., 2019). Yet there is need for stronger regulatory frameworks and inter-departmental coordination mechanisms to make links between UPA, health, and the environment (Binns et al., 2003). Ultimately, remaining cognizant of historical-geographic specificities at the city and intra-city scales remain pertinent for designing equitable policy support for UPA.

5. Conclusion

Overall, the literature on UPA has been growing steadily with an exponential increase in the last decade (for illustration, more than 90% of the 320 articles assessed were published after 2015). There is a clear geographical bias in the literature with the largest proportion of papers from the Global North and fewer in the Global South. Thematically,

environmental outcomes of UPA were most discussed, followed by impacts on subjective wellbeing and food and nutritional security. Gender and issues of social difference were least represented in the papers, signalling a key knowledge gap. Notably, papers from the Global North (Europe, UK, North America and Canada, Australia and New Zealand) primarily focused on positive environment outcomes but mixed social outcomes, while those from the Global South (Sub-Saharan Africa, Southeast and East Asia, South Asia, Latin America and Caribbean) reported UPA’s positive contributions to social sustainability. Under the economic sustainability pillar, positive impacts of UPA on livelihoods and uncertainties associated with land governance/insecurity seemed key topics identified more commonly in the Global South.

Our thematic analysis suggests that UPA responds to several of the SDGs: accessible and affordable food to reduce hunger (SDG2), diverse, healthy and nutritious food for good health (SDG3), equitable access to vulnerable communities (SDG5, SDG10), urban risk management and climate mitigation through reduced food miles (SDG11, SDG13), sustainable production and consumption benefits through minimising synthetic inputs and recycling waste to produce food (SDG12), better water and nutrient recycling, improved soil health and biodiversity (SDG 15) and improved environmental awareness and pro-environmental values (possibly SDG 17). Yet there appears to be no composite assessment of these multiple benefits across sustainability dimensions, hence missing an opportunity to leverage UPA to meet the SDGs and improve urban resilience.

The literature clearly indicates the need for mainstreaming and formalizing UPA (with equitable outcome as the driving principle) as part of urban planning to counter the uncertainties that threaten long-term urban commitments, investments, and environmentally sustainable practices. For policy-level changes to occur, it seems imperative that more in-depth case studies and comparative research is conducted to address knowledge gaps around the sustainability outcomes and wellbeing co-benefits of UPA, related particularly to urban food insecurity, poverty and inequality. Such assessments will build confidence in the sustainability perceptions of UPA amongst producers, consumers, and most critically, policy makers. We put forth this review as one step in this direction.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Since the paper is systematic review, it uses only secondary literature

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Appendix 1

Tables A1–A3

Appendix 2

Table A4

Appendix 3

Table A5

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