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EDITED BY
Amalia Zucaro,
Energy and Sustainable Economic Development (ENEA), Italy

REVIEWED BY
Pablo Torres-Lima,
Metropolitan Autonomous University, Mexico
Megan Maurer,
University of Copenhagen, Denmark

*CORRESPONDENCE
Karen Puren
✉ karen.puren@nwu.ac.za

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Fighting the hunger games through permaculture: a scoping review to inform urban planning

Denise Janse van Rensburg and Karen Puren*

Urban and Regional Planning, School of Geo and Spatial Sciences, North-West University, Potchefstroom, South Africa

In 2020, more than seven million people across the globe starved, and 868 million people were estimated to be undernourished globally. Although the eradication of hunger is a noble goal, the continuously growing world population together with the warning of a future characterized by food insecurity spells ongoing hardship for the future of humankind. This study explores the extent of permaculture literature to establish its potential place within urban systems. A scoping review looks at permaculture literature from the last 8 years to establish its benefits and limitations, possibly within urban systems. Permaculture is mainly studied from social, environmental, and economic perspectives, and mostly within rural contexts. Urban planning directly concerns the social, environmental, and economic dimensions of urban systems. This study thus reveals the possible merits of permaculture for food production within urban systems; however, certain limitations should be kept in mind that may encumber the implementation of permaculture by urban planning.

KEYWORDS

permaculture, urban planning, food systems, urban systems, hunger, regeneration

1. Introduction and background

> *"… We say, let us give the child an education modeled on permaculture; something that needs and returns nurture. It is time to turn the ebbing tide of energy toward useful ends and develop a permaculture for the society of man and nature."*
> Mollison and Holmgren (1990)

The United Nations has set a universal goal (Sustainable Development Goal 2) to eliminate global hunger by 2030 (United Nations, 2015), However, since 2015, the number of people suffering from hunger has increased. Over 800 million people globally are undernourished and over eight million people have died from starvation (The World Counts, 2022). Currently, Africa is one of the continents most severely affected by hunger (Statista, 2022). The alarming levels of hunger are exacerbated by significantly high rural-to-urban migrations (Davies et al., 2021; Haysom, 2021; Steenkamp et al., 2021). Although Africa is the least urbanized continent in the world with only 44% of its population residing in urban areas, the continent is currently experiencing some of the highest urban population growth rates in the world due to urbanization (Ali, 2021; Vasyviela and James, 2021; Gambe et al., 2023). This situation calls for a critical intervention in urban areas on the African continent to address food insecurity (Haysom, 2021; Vasyviela and James, 2021). The sub-Saharan Africa context in particular faces the most serious problem with food insecurity. This is verified by the Food and Agriculture Organization (FAO) [Food and Agriculture Organization of the United Nations (FAO), 2020], which reports that sub-Saharan Africa has the highest rate of undernourishment in the world, with over 23.2% of its population

suffering from chronic hunger. Together with the high demand for food production as a side effect of urbanization in the area, poor urban planning can exacerbate food insecurity. For instance, in many sub-Saharan African cities, ineffective transportation systems, a lack of infrastructure for food delivery, and restricted access to affordable, nutrient-rich food are prevalent problems [High Level Panel of Experts (HLPE), 2017]. Urban planners need to address sustainable urban food programmes, enhance food supply chains, and support equal access to food resources within urban regions to address these issues. According to the UN-Habitat [United Nations Human Settlement Programme (UN Habitat), 2014], cities in sub-Saharan Africa can seek to reduce hunger and improve the general wellbeing of their citizens by including food security considerations in urban planning and design initiatives.

Several solutions have been offered across different disciplines to address food insecurity in urban environments, e.g., through urban agriculture (Slade et al., 2016; Siebert, 2019; Steenkamp et al., 2021), food-sensitive planning (Haysom, 2021) and infrastructure gardening (rooftops and vertical gardens) (Choudhary and Rawat, 2021). In addition, permaculture (derived from the words "permanent" and "agriculture" and introduced in the 1970s) has been proposed in the literature as a potential tool for addressing food insecurity. However, despite a significant rise in food-related research across disciplines, permaculture's emphasis on food production in cities has garnered little attention. Furthermore, while topics, e.g., urban agriculture and green infrastructure have been incorporated into the planning of urban environments (Slade et al., 2016; Mui et al., 2021; Steenkamp et al., 2021), reference to the integration of permaculture in urban planning is almost non-existent.

While permaculture has been promoted primarily as a design approach, its potential application in the context of urban planning and design remains an area of limited research. A further concern is that much less permaculture research has been directed to the African continent than in other countries, especially in sub-Saharan Africa where the need for food is critical. This gap is addressed in this paper by investigating the extent of permaculture as a possible tool for addressing food insecurity with specific reference to possible links with urban planning. The main purpose of the literature study presented here was to investigate the range of aptitudes permaculture offers as a food system and to identify potential prospects to inform urban planning initiatives to combat food insecurity. The main research question that has guided the investigation is: "To what extent has permaculture been addressed in the literature and what are its prospects to inform urban planning in addressing food insecurity?" Fighting hunger in highly urbanized cities by considering permaculture may well provide fertile ground to seek an answer to this question.

1.1. Contextualizing permaculture, urban systems, regenerative systems, and urban planning

The purpose of this section is to provide the theoretical framework that underpins the research. The framework comprises the concepts of permaculture, urban systems, regenerative urban systems, and urban planning.

1.1.1. Permaculture

Permaculture, initially introduced by Bill Mollison and David Holmgren in the late 1970s, was offered in relation to alternative and small-scale farming initiatives as a design framework for creating sustainable systems that function in harmony with nature (Leahy, 2021). In permaculture systems, people and the environment are integrated in a harmonious whole to provide food while addressing basic needs such as shelter, water, and other materials (Mollison and Holmgren, 1990; Moughtin and Shirley, 2005; Mang and Reed, 2012; Philips, 2013). The approach is based on observing and replicating the patterns and processes found in natural ecosystems, with the goal of developing systems that are self-sustaining and require minimal human intervention (Holmgren, 2002; Salleh et al., 2018; Leahy, 2021). Furthermore, permaculture aims to establish agricultural ecosystems that replicate natural ecosystems to provide food, preserve biodiversity, deliver ecosystem services, and require minimal maintenance. The principles and ethics of permaculture are based on complex-system[1] thinking and rooted in 12 design principles and three ethical principles (Holmgren, 2002; Philips, 2013). The initial idea of permaculture as a food system design evolved toward permaculture as a holistic system design approach, as presented in Figure 1. This tool has been applied in developing countries globally over a period of 50 years, e.g., in Malawi (Rivett et al., 2018), South Africa (Kruger, 2015), the Philippines (Flores and Buot, 2021), Zimbabwe (Didarali and Gambiza, 2019), and India (Fadaee, 2019), albeit to a limited extent, but has not remained stagnant. Across the world, permaculture evolved from being used as an intimate small-scale food-growing practice for private application into a practice that is recognized for its wide-reaching pertinence within systems of various sizes, types, and scales. Although permaculture was originally developed as a holistic way of integrating food-growing systems into human systems, its potential integration in urban systems is still underexplored (Howe, 2002; Viljoen et al., 2005; Cabannes and Marocchino, 2018; Ulbrich and Wostl, 2019; Lapoutte, 2020). Existing permaculture literature is mainly focused on rural contexts in response to food provision, system regeneration, and/or addressing social issues. Limited recent examples in which permaculture has been researched in urban contexts include a study by Babac and Belic (2018) in the Balkan region, which focused on how agroecological practices, biodiversity conservation, soil health and supporting communities can contribute to more efficient systems, and a study by Salleh et al. (2018), which reviewed the literature on permaculture and its principles to analyse how these principles

1 Complex systems are systems that have continually changing components with strong interactions between various elements in- and around the system and their dependability on each other (Bak, 1996). Complex systems are also shaped by the unpredictability of internal and external shocks to the system and their ability to adapt patterns based on the feedback from these disturbances (Miller and Page, 2007; Carmichael and Hadikadic, 2019).

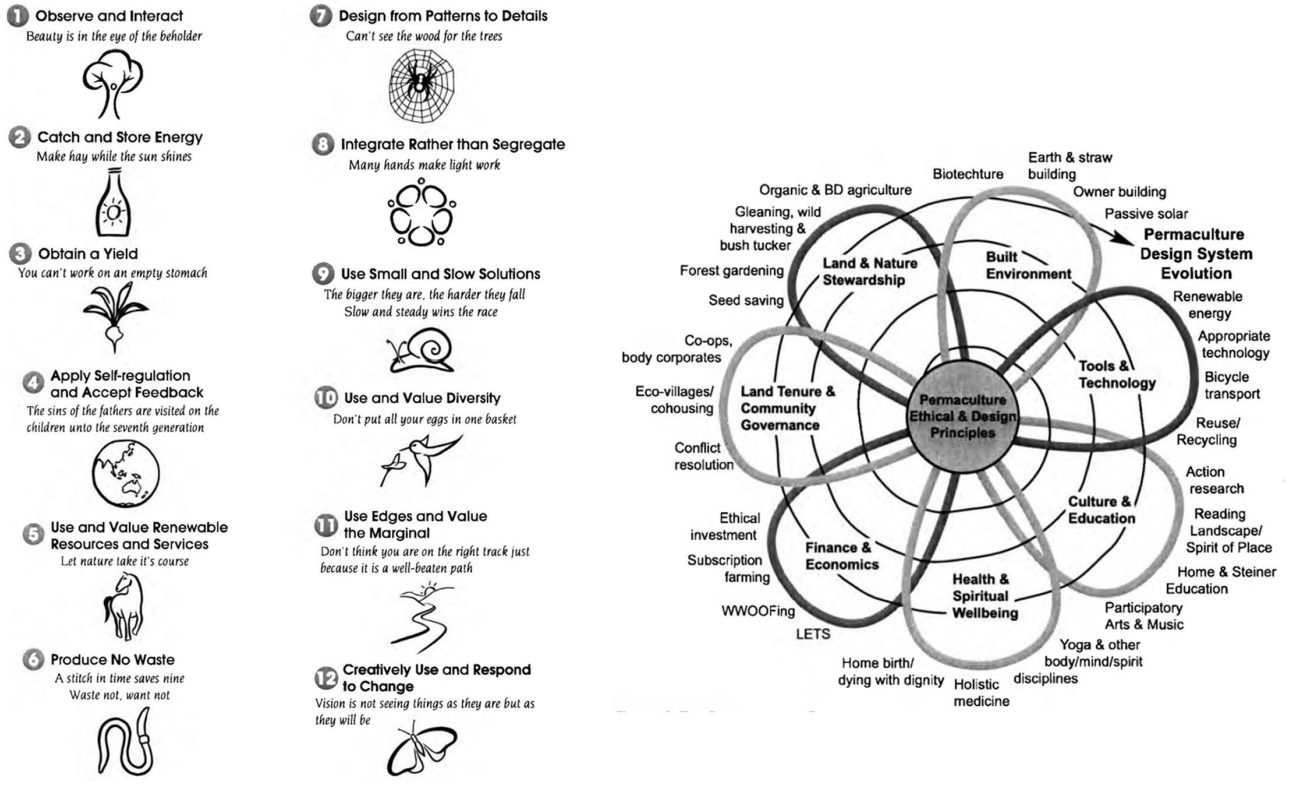


FIGURE 1
Permaculture principles and ethical values. Source: Holmgren (2002).

align with the United Nation's Sustainable Development Goals. In the latter, the authors argued for a holistic framework to achieve sustainable development by integrating ecological, social, and economic considerations. A study by Shaojie et al. (2019) followed that explored the significance of outdoor landscapes to inform the design of contemporary primary schools in Hefei city in China. Although originated from agriculture, these studies echo the flexibility of a permaculture system as propagated by Mollison and Holmgren in the 1990s. Despite the variety of studies that are mentioned here, the potential application of permaculture in urban environments has yet to be fully explored, and further research is needed to understand how it can be applied in urban areas, especially concerning food systems. It is especially concerning that while permaculture has been considered through the lenses of various disciplines, the contribution from an urban planning and design perspective is almost non-existent in scholarship. In view of Sustainable Development Goal 11: Sustainable cities and communities, which calls for the planning of inclusive, safe, resilient, and sustainable cities and human settlements (United Nations, 2015), an investigation of permaculture as a possible urban food system tool seems to be a fruitful topic for further exploration—especially in contexts such as that of sub-Saharan cities where food security is a pressing reality in the future of growing cities.

1.1.2. Urban systems

A sustainable urban system refers to the interconnected network of physical, social, economic, and ecological components that make up a city or metropolitan area (Taylor, 1998; Nichersu and Iacoboaea, 2011). This system includes the built environment, e.g., buildings, roads, infrastructure, the natural environment—such as open spaces, rivers, wetlands—and the social and economic networks that facilitate the movement of people, goods, and capital within the urban area (Brudermann et al., 2016). Urban systems are characterized by higher population densities and greater concentrations of economic activity compared to rural areas. Consequently, these systems often face unique challenges related to sustainability, specifically with respect to resource depletion, pollution, climate change, and food security (Wilson and Piper, 2010; Pickett et al., 2013; Battersby and Watson, 2019). These challenges call for a reconsideration of how urban systems can be transformed into regenerative systems.

1.1.3. Regenerative systems

In essence, regeneration is the ability of a system to sustain itself in the face of external disturbances, as described by Rhodes (2015). Regeneration stems from resilience thinking where a system has the potential to transform itself in response to shocks and

disturbances (Holden et al., 2016; Legaspi et al., 2016). The concept of resilience concentrates on the importance of the system subjected to shock in returning to its original state. Regenerative thinking takes resilience a step further by enabling systems that can self-adapt to disturbances and adjust their threshold for future disturbances (Cole, 2012; Caniglia et al., 2020). In that respect, regeneration involves designing a system that can withstand and reconcile the damages caused by external shocks while continuing to provide for its consumers, whether they are people, organisms, animals, or others. Hence, permaculture as a food system is a design method that goes beyond the traditional notions of sustainability and resilience to create regenerative systems (Rhodes, 2015; Caniglia et al., 2020; Izadi et al., 2020). Permaculture specifically focuses on creating regenerative food systems that provide for the interactive components of an integrated system. Unlike other urban food systems (e.g., urban agriculture and aquaponics), the primary advantages of permaculture, also embedded in its principles (Principle 9: small and slow solutions), are flexibility and adaptability to different scales (Mollison and Holmgren, 1990; Holmgren, 2002). By incorporating regenerative design principles such as minimizing waste, maximizing diversity, and creating closed-loop systems, permaculture aims to create regenerative food systems that not only meet the needs of the present consumer but also continually regenerate the system to provide for future consumers (long-term dependability). The incorporation of permaculture into urban areas as a measure to regenerate urban food systems may well become a much-needed urban planning tool for alleviating food insecurity in growing urban contexts.

1.1.4. Urban planning and food security

Urban planning is the arrangement of components (roads, public spaces, residential areas, social hubs, business districts, etc.) within urban systems to create thriving communities to live in Metternicht (2018). Furthermore, urban planning is directly responsible for structuring urban systems in a way that ensure prosperous communities and more recently consolidative people-nature systems (Taylor, 1998; Shen and Kawakami, 2013). Also, urban planning facilitates infrastructure planning, determines viable land use arrangements, ensures the equitable use of resources, and is orientated around sustainably resolving conflicts of space (Metternicht, 2018). From an urban planning perspective, innovative and flexible planning tools and approaches must be pursued and developed for fighting the advancing challenges of ongoing urbanization, society, and subsequential issues such as hunger which is currently one of the most important urban challenges to address in Africa (Davies et al., 2021).

The idea of incorporating food production in the planning of urban environments is not new. Countless academic endeavors have explored the integration of food into urban systems in one way or another. The most common topics researched in this regard include *inter alia* urban agriculture, rooftop gardens, vertical gardens, and aquaponic systems (Badami and Ramakutty, 2015; Goddek et al., 2015; Choudhary and Rawat, 2021). These initiatives all show promising prospects for addressing urban food concerns but often lack flexibility and adaptability for dynamic contexts.

One urban and planning approach that focuses on addressing food security is urban agriculture. It is one of the most popular approaches for integrating food into urban systems and is the practice of integrating large- and medium-scale agriculture into urban systems mainly to provide food and ecosystem services to the surrounding urban communities (Badami and Ramakutty, 2015). However, urban agriculture is criticized for its application in large open spaces with healthy soil available in urban areas while, similarly to traditional agriculture, land availability and tenure constraints are prominent shortcomings (Horst et al., 2017; Audate et al., 2019; Davies et al., 2021). Urban agriculture is also a costly process that requires traditional sowing, plowing, and reaping techniques and often produces monocrops that fail to support biodiversity (Badami and Ramakutty, 2015).

Another approach that has received attention in the past decades is the use of rooftop and vertical gardens, recognized for its efficient utilization of urban infrastructure to grow food (Choudhary and Rawat, 2021). Rooftop gardening is the practice of utilizing building rooftops for gardening and crop cultivation. Vertical gardening is the practice of employing vertical stacking to grow crops and is often used for hydroponic and aeroponic systems (Horst et al., 2017). Rooftop gardens and vertical gardens are both revered for reducing the environmental footprint of food production operations while providing ecosystem services in cities and for their efficient use of space in densely populated urban areas (Ekren, 2017). However, rooftop and vertical gardening have been criticized due to the incapacity of existing infrastructure to support these practices and cost ineffectiveness for maintaining these systems in terms of leakage prevention, preparatory construction, and soil and water management (Ekren, 2017; Wang, 2018).

Aquaponics is another food-generating practice where aquaculture (fish farming) is combined with hydroponics (soilless plant cultivation) to create a symbiotic relationship where fish waste provides nutrients for plants in a closed system (Goddek et al., 2015). Although a relatively novel practice, aquaponics has been researched quite extensively in urban contexts due to its unique nature and its efficiency in water use (Yep and Zheng, 2019). Although popular, the significant amount of financial and resource input for aquaponics to function efficiently together with high disease risks associated with using fish and plants are main points of criticism (Yep and Zheng, 2019; Turnsek et al., 2020).

Relative to other approaches, it is argued that permaculture offers a promising, more flexible, adaptable and affordable approach to producing food in cities. By designing integrated urban food systems that mimic natural ecosystems, permaculture can help foster resilient and regenerative urban environments on the environmental, social, economic, and physical (planning and design) dimensions. Permaculture principles can guide the planning and design of urban spaces to enhance biodiversity, conserve resources, reduce waste, provide food, and foster community resilience (Leahy, 2021). Sustainability in urban systems is increasingly questioned in academic scholarship due to the popular interdisciplinary use of the terminology to promote business-as-usual under the pretense of adapted ecological awareness within organizations and procedures (Ang and Van Passel, 2012; Rhodes, 2015; Holden et al., 2016). Resilient and regenerative systems, on the other hand, have been endorsed to

be the latest aspirations for the future preservation of systems, especially urban systems (Cole, 2012; Rhodes, 2015; Caniglia et al., 2020). It is in this sense that the potential of integrating permaculture in urban systems as a regenerative food system looks promising. The question remains to what extent permaculture has been researched as a potential tool to create sustainable and regenerative urban food systems and how it can be integrated into urban planning to address food insecurity.

2. Methodology

2.1. A scoping review

To answer the question "To what extent has permaculture been addressed in the literature, and what are its prospects for urban planning?" A scoping literature review was conducted. Various authors (e.g., Arksey and O'Malley, 2005; Levac et al., 2010; Peters et al., 2015) agree that scoping reviews involve synthesizing existing knowledge to explore a research question and map key concepts, types of evidence, and research gaps in a defined field or area. While similar to traditional systematic reviews, scoping reviews differ in their methodology and are better suited to the objectives of this study.[2] Systematic reviews are typically focused on answering well-defined questions through a rigid protocol, whereas scoping reviews allow for a broader exploration of the literature to map key concepts and can be less specific (Levac et al., 2010; Peters et al., 2015). A scoping review is considered here as a first step prior to conducting an exhaustive literature study to provide some initial insights about a topic (i.e., permaculture) that has received little consideration in urban contexts or urban planning. In this case, the scoping literature review is used to provide a brief overview of existing permaculture research to create a better, more nuanced understanding of the current state of this topic in research. It is also used to identify potential areas for further investigation and inform perspectives that have previously not been accounted for (in this case an urban planning perspective). Additionally, a scoping review was recommended to identify potential barriers and facilitators to the implementation of permaculture practices in different contexts, and thus to contribute to the development of policies and programmes that promote sustainable food systems (Hanc et al., 2019; Van Huizen et al., 2021). It is argued here that a scoping review is a necessary first step to address complex research questions where knowledge gaps are present in an existing body of literature (permaculture) and where research from the urban planning discourse is limited.

2.2. Search strategy, literature selection, and exclusions

The solid foundation and specified nomenclature of permaculture made locating relevant papers relatively easy. To ensure a comprehensive search, the terms "permanent agriculture" and "permanent culture" were included with the same limiting factors as "permaculture." These limiting factors included full-text papers available in English only and published in peer-reviewed academic journals. The decision to use peer-reviewed papers was because their literature holds the most significance and accuracy in scientific publications. Only research papers that were published in academic journals were considered in the search to ensure authenticity and validity. The time span of the research was limited to 2015–2021 to ensure a scoping review that is informed by recent findings. Other exclusion[3] criteria included research that was not conducted from perspectives relevant to this study (social, environmental, business, or spatial perspectives) or studies that fell within saturated discussions of permaculture e.g., many studies have explored permaculture as a land regeneration tool. Thus, a certain number of articles were selected to represent a saturated phenomenon in this review. A comprehensive search was conducted across several academic databases, including Science Direct, Scopus, Sage, Directory of Open Access Journals, Web of Science, and Google Scholar.

To ensure that earlier trends in permaculture literature were not overlooked, a search (with the same limiting factors) was conducted for the years 1985 to 2014. This period (29 years) yielded a meager 16 papers which were not available in full text. The papers were scrutinized for trustworthiness and thoroughness based on the purpose of this review. This review intends to address a research phenomenon combination that has not trended in studies since 1985–2014. The search for eligible literature yielded 113 papers, but after removing duplicates and ineligible sources, 46 peer-reviewed journal articles between January 2015 and December 2022 remained that were eligible for further analysis. Eligible studies included those with the search terms in their title, expanders, and limiters, and those that focused on permaculture research across all dimensions over the past 8 years (to represent recent trends in permaculture). To identify the extent of permaculture research, the urban planning discipline's contribution and the status quo of permaculture literature, the eligible papers were systematically scanned using a database system. Titles, abstracts, and disciplines were screened to categorize key perspectives, disciplines, and research methodologies, and ultimately to establish a representative

2 The decision to perform a scoping study of permaculture literature that is limited to full-text articles in English, published in peer-reviewed scholarly journals between 2015 and 2022, offered several advantages. Firstly, it enhances rigor and quality control through expert scrutiny of the chosen literature. Secondly, by focusing on English-language publications, it broadens the audience, facilitating knowledge sharing within and beyond the permaculture community due to English's global academic and communication prominence. This approach provides a systematic framework for scoping the existing academic discourse on permaculture, albeit potentially omitting non-English publications and gray literature. These limitations are justified as they prioritize scholarly rigor, accessibility, and comprehensibility while acknowledging potential inclusivity trade-offs. The limitations do not exclude intellectual criteria (e.g., topics or perspectives) but rather non-material criteria to ensure that an adequate body of literature is considered to represent the topic.

3 A subcategory of literature that explores exclusive problems from unanticipated perspectives, including tourism, psychology, engineering, religious studies, political fields, feminist theology, naval architecture, and anthropology were excluded from the scoping review as the literature within these subcategories falls outside the scope of this paper.

body of literature to be reviewed that signifies the extent of permaculture literature to date.

In search of studies that attempted to exceed standard thematic boundaries, it was detected that permaculture is mostly researched from three specific perspectives, namely permaculture intervention from social, economic, and environmental perspectives. With the aforementioned also being the fundamental dimensions of sustainable urban systems, a body of literature was selected that represents the main researched approaches within permaculture research to obtain possible lessons that can inform urban planning. Regrettably, nearly all the permaculture literature has been conducted in rural contexts and with only limited reference to urban contexts (see Babac and Belic, 2018; Salleh et al., 2018; Shaojie et al., 2019; Fiebrig et al., 2020). As urban systems are made up of social, environmental, and economic dimensions, it is deemed appropriate to review the permaculture literature accordingly. Thus, after assessing the titles, abstracts, and field of disciplines of the 46 eligible papers, 31 were selected for the scoping review. The selected literature represents novel research as well as saturated research on the positions of permaculture from social, economic, and environmental perspectives, in the hope that these permaculture perspectives may shed useful knowledge to inform urban planning initiatives when it comes to urban food systems.

Firstly, as this study has an overarching urban planning perspective, papers conducted from a built environment/spatial focus were immediately selected (3). These included papers from urban planning, architecture, and design fields. Papers that were considered especially significant from the initial selection were those conducted from social and/or environmental perspectives. These included agriculture, biology, ecology, sustainability, sociology, philosophy, anthropology, and cultural study fields (23). Finally, due to their regularity and popularity, the selection could not overlook a third area of focus, namely the business and economic area. This area included the fields of marketing, business management, economics, and education (7). See Figure 2 for the search strategy and selection as well as the research methods and foci distribution of the selected literature.

Two frameworks were used to structure and conduct the scoping review: Hanc et al. (2019) framework for scoping reviews and Arksey and O'Malley (2005) framework for scoping studies. Arksey and O'Malley's framework was used to guide the selection and analysis of the literature, while Hanc et al. (2019) framework was used to identify and analyse the key themes and trends in permaculture literature.

3. Findings

Figures 2, 3 illustrate the structural findings of this study, including the locality, perspectives, and research methods used in the selected literature. In Figure 2, it is illustrated that 67% of the studies presented in the literature used a qualitative research approach, 16% a quantitative approach, and the remaining 17% a mixed-methods approach. The geographical distribution of the studies conducted is presented in Figure 3, with green indicating studies that focus on environmental perspectives, yellow on social perspectives, blue on business and economic perspectives, and red on built-environment perspectives. Figure 3 provides a visual overview of the diverse perspectives and approaches used in permaculture scholarship. When examining the perspectives and the distribution of the selected literature, as depicted in Figure 3, we can already see how permaculture's multifaceted nature demonstrates its ability to be applied in the wide array of environmental, social, and economic context. Three primary focuses in permaculture emerged from the scoping review: (i) an environmental focus, (ii) a social focus, and (iii) an economic focus. These focuses revolve around key concepts of permaculture that have been investigated in various contexts. The relation between the themes that are identified in the literature and urban planning is considered to address the purpose and research question as provided in the introductory section of this paper.

3.1. Main theme 1: an environmental focus

In this paper, an environmental focus refers to the study of ecosystems and their interconnected elements, with permaculture as a key component. Research on permaculture in environmental studies focuses primarily on preserving ecosystems with sustainable food production for future generations. A variety of sustainable food production methods have been explored in the literature, with a focus on papers published between 2015 and 2022. This review has identified four sub-themes within this research area: (i) permaculture as an agroecological system (Section 3.1.1), (ii) permaculture as a tool for land regeneration (Section 3.1.2), (iii) permaculture for commercial agriculture (Section 3.1.3), and (iv) permaculture in landscape design (Section 3.1.4). These sub-themes highlight the various ways in which permaculture can contribute to the preservation and restoration of ecosystems while simultaneously promoting sustainable food production.

3.1.1. Sub-theme 1: permaculture as an agroecological system[4]

Agroecological systems as farming systems aim to integrate ecological principles and biodiversity into agricultural practices (Krebs and Bach, 2018; Oliveira et al., 2022). These systems are focused on creating sustainable, resilient, and productive farms by working with natural processes rather than relying on synthetic inputs e.g., pesticides and fertilizers (Grant and Yasue, 2017). Agroecological systems evolved from the concerns regarding traditional or conventional agricultural practices that can trigger *inter alia* the loss of biodiversity[5], monocropping[6], and/or soil degradation[7] (Grant and Yasue, 2017; Flores and Buot, 2021). According to Grant and Yasue (2017) and Ferguson and

4 Agroecology is a holistic method that applies ecological and social notions to agriculture to create more sustainable and resilient agricultural food systems (Grant and Yasue, 2017:432 and Krebs and Bach, 2018:1).

5 Decrease in the variety of species and amount of genetic variation in an ecosystem.

6 The cultivation of a single genetic species crops annually on the same portion of land.

7 The deterioration in soil quality caused by poor use or management thereof and typically influenced by agricultural and urban activities.

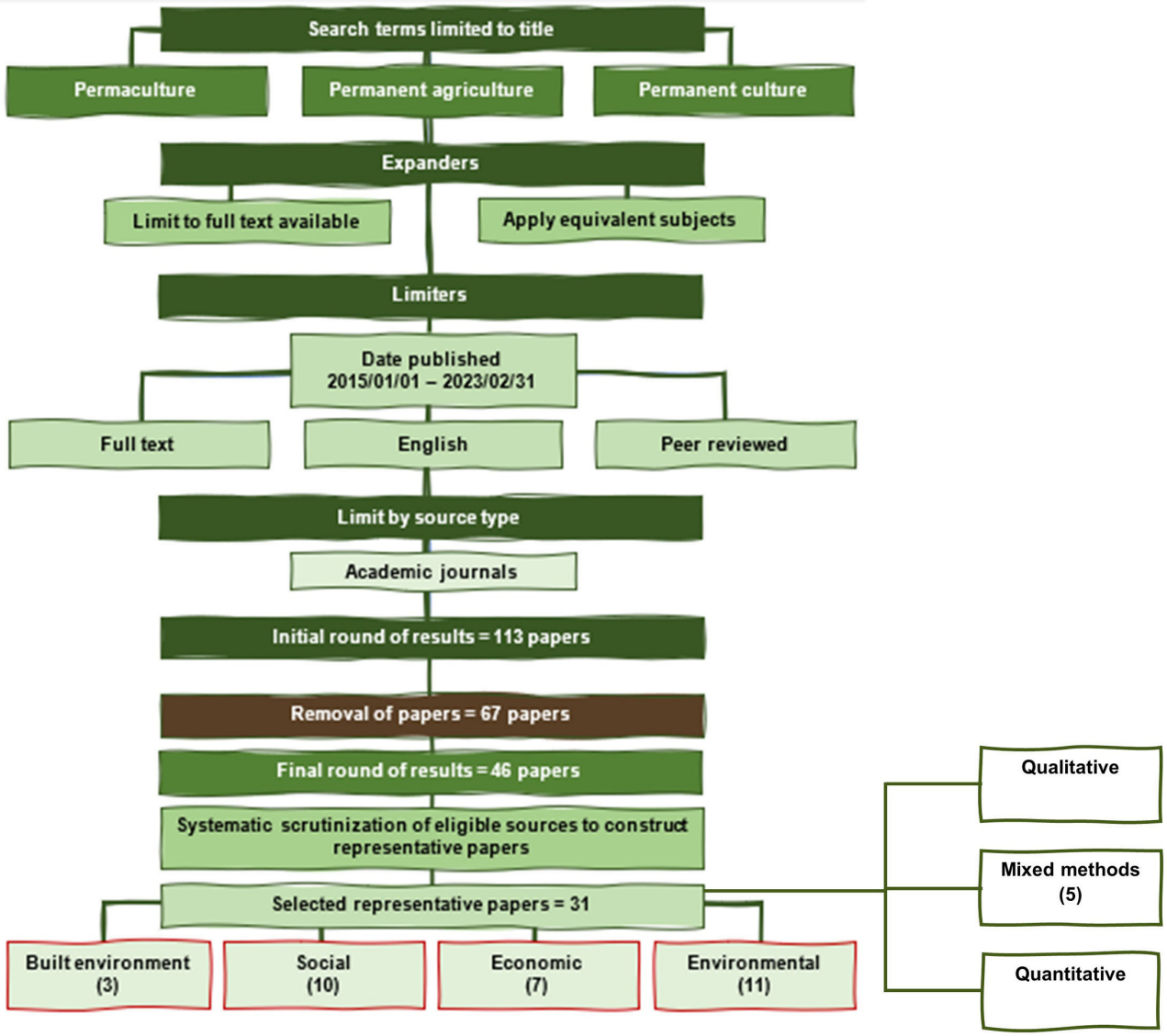
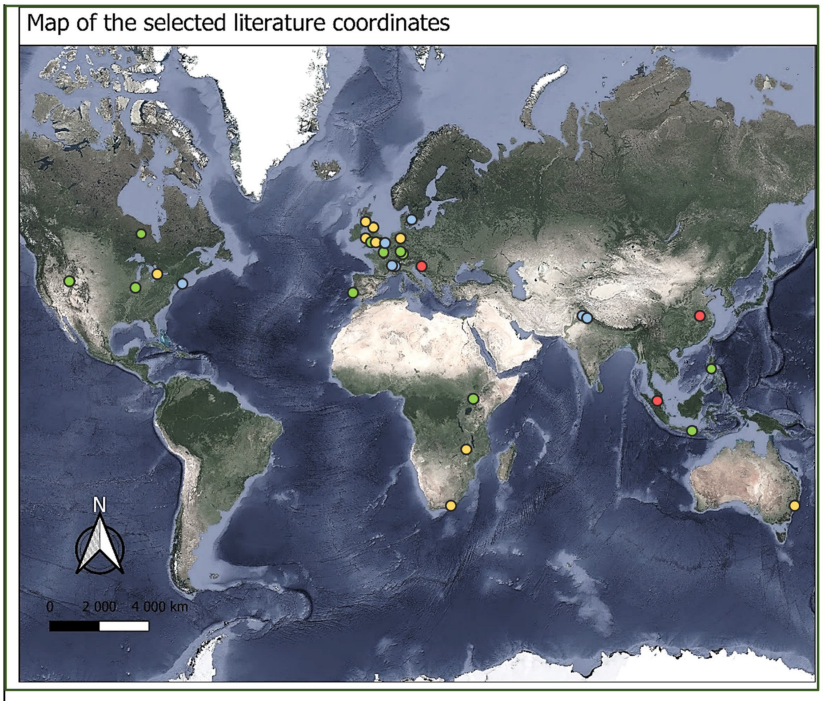


FIGURE 2
Data search and selection process for papers for scoping review and research methods and foci distribution of the selected. Source: Author's compilation.

Lovell (2017), permaculture can be used to create diversified, resilient agroecosystems that have the potential to enhance rural livelihoods and increase rural people's competence and independence. However, Krebs and Bach (2018) and Hirschfeld and Van Acker (2022) illuminate that permaculture design along with its unique principles has not received the necessary in-depth investigation to guide the design, implementation, and maintenance of agroecological systems, thus leaving a gap for further investigation. Further scientific evidence for permaculture from an environmental perspective is provided by Krebs and Bach (2018), who point to the effectiveness of permaculture as a design approach in strengthening agroecosystems by weighing the implementation of the 12 principles against the intentions of agroecology. One of the most important findings from these studies relates to the fact that permaculture may well contribute to higher crop and species diversity, land heterogeneity, and perennialization toward agroecological practices (Putro and Miyaura, 2020; Hirschfeld and Van Acker, 2022). Furthermore, permaculture may add to the maintenance and strengthening of ecosystems as found by De Tombeur et al. (2018), emphasizing its reutilising characteristics in terms of the soil from permaculture practices that deliver overall higher physiochemical properties and nutrient bioavailability (organic carbon, nitrogen, calcium, magnesium, potassium, and phosphorus) than that of traditional agriculture (De Tombeur et al., 2018). This highlights the indispensable ability of permaculture systems to not only maintain existing ecosystems but also regenerate them.

A close link exists in the literature between agroecological systems and food security, as it increases the availability, accessibility, and affordability of nutritious food. This approach



LEGEND

	AUTHOR/S	DATE	LOCATION
ENVIRONMENTAL	DE TOMBEUR, F. ET AL.	2018	NORMANDY, FRANCE
	FERGUSON, R.S. & LOVELL, S.T.	2017	ILLINOIS, UNITED STATES
	FIEBRIG, I. ET AL.	2020	STUTTGART, GERMANY
	FLORES, J.J.M. & BUOT, I.E.	2021	LAGUNA, PHILIPPINES
	GRANT, K.J.H. & YASUE, M.	2017	BUTULA, KENYA
	HIRSCHFELD, S. & VAN ACKER, R.	2019	ONTARIO, CANADA
	KREBS, J. & BACH, S.	2018	LANDAU, GERMANY
	MAYE, D.	2018	GLOUCESTERSHIRE, ENGLAND
	OLIVEIRA, H. & LOPES, G.P.	2020	LISBOA, PORTUGAL
	PUTRO, R.H. & MIYAURA, R.	2020	BALI, INDONESIA
	VON COSSEL, M. ET AL.	2020	STUTTGART, GERMANY
SOCIAL	AIKEN, G.T.	2017	DURHAM, UNITED KINGDOM
	DIDARALI, Z. & GAMBIZA, J.	2019	GRAHAMSTOWN, SOUTH AFRICA
	FADAEE, S.	2019	MANCHESTER, UNITED KINGDOM
	FERGUSON, R.S. & LOVELL, S.T.	2015	ILLINOIS, UNITED STATES
	HENFREY, T.W.	2018	BRISTOL, UNITED KINGDOM
	HINTON, R.G.K. ET AL.	2021	LILONGWE, MALAWI
	KARIM, M.E.	2018	SOUTH WALES, AUSTRALIA
	MILLNER, N.	2016	BRISTOL, UNITED KINGDOM
	SPANGLER, K. ET AL.	2021	LOGAN, UNITED STATES
	ULBRICH, R. & WOSTL, C.P.	2019	OSNABRUCK, GERMANY
BUSINESS & ECONOMICS	AKHTAR, F. ET AL.	2015	LAHOE, PAKISTAN
	AKHTAR, F. ET AL.	2016	LAHOE, PAKISTAN
	GENUS, A. ET AL.	2021	KINGSTON, UNITED KINGDOM
	JELINEK, R.	2017	RHODE ISLAND, UNITED STATES
	LAPOUTTE, A.	2020	LYON, FRANCE
	ROCHA, S.S.R.	2022	AARHUS, DENMARK
	VITARI, C. & DAVID, C.	2016	LYON, FRANCE
BUILT ENVIRONMENT	BABAC, S. & BELIC, D.	2018	ZAGREB, CROATIA
	SALLEH, A.M. ET AL.	2018	PERAK, MALAYSIA
	SHAOJIE, Z.	2019	HEFEI ANHUI, CHINA

FIGURE 3
Locality of selected literature. Source: Author's compilation.

can lead to higher yields and lower input costs, making it a more sustainable and cost-effective way to produce food, particularly in resource-constrained areas. Additionally, agroecological systems often prioritize the production of diverse crops and livestock, which can help increase dietary diversity and provide a wider range of essential nutrients. This is particularly important for food security, as malnutrition and hunger are often linked to a lack of dietary diversity (Krebs and Bach, 2018; Hirschfeld and Van Acker, 2022). However, a lack of integration of agroecological systems and permaculture in urban environments is one of the research gaps that emerged from the literature review.

3.1.2. Sub-theme 2: permaculture as an instrument for land regeneration

Due to high quantities of abandoned rural landscapes and agricultural land and soil degradation, Oliveira and Lopes (2020) explored permaculture as a way to revitalize land, as food production is directly dependent on the quality of the soil in which the crops are cultivated. These authors used a socio-ecological inventory to characterize social movements and discovered that young male adults primarily practice grassroots movements like permaculture to revitalize degraded land. They concluded by recognizing that permaculture can bring young land stewards to the forefront to recreate livelihoods (Oliveira and Lopes, 2020). Likewise, Von Cossel et al. (2020) study focused on the application of permaculture as an improved approach for the renaturation of quarries in the temperate zone (regions with moderate annual rainfall, infrequent droughts, moderately warm summers, and moderately cold winters) that are commonly renatured by the planting of indigenous flora that have no further use. In this study, permaculture is considered in quarry renaturation for its ability to improve the soil by producing food, giving the former quarries more valuable ecosystem services following their renaturation (Von Cossel et al., 2020).

Permaculture as a land regeneration instrument is closely linked to food security, as it can be applied to create sustainable food systems that are resilient to environmental and economic challenges. Furthermore, permaculture principles prioritize the use of natural processes and ecosystem services to produce food, while also regenerating the soil, conserving water, and enhancing biodiversity. The recent studies mentioned here indicate how permaculture can be a powerful instrument for both land regeneration and food security, as it prioritizes sustainable food production, regenerates the soil and ecosystem, and thus builds resilient and diverse food systems that can adapt to changing conditions.

3.1.3. Sub-theme 3: permaculture as commercial agriculture practice

Commercial agriculture refers to large agricultural enterprises, also known as conventional farming, that produce food on a large scale with the sole purpose of retailing the produce

to the industrialized food market. In contrast, permaculture is traditionally a non-commercial rural farming practice (Fiebrig et al., 2020). Fiebrig et al. (2020) recognize that permaculture is in dire need of engagement by a wider group of professionals and suggest it to be incorporated into commercial farming to deliver produce for profit whilst earning from its beneficial characteristics. The integration of permaculture into commercial farming practices presents a shift from traditional agriculture to more sustainable and environmentally friendly ways to grow crops and raise livestock. Permaculture can be recognized as a holistic approach to agriculture that emphasizes the creation of self-sustaining ecosystems that mimic natural patterns and processes. The outcome of such an approach is an improved health of agricultural land through the reduced need for chemical inputs. Specific benefits of such approaches include creating higher yields, better quality produce, and reduced costs over time. In terms of addressing food security, an integrated approach entails a shift toward more sustainable and regenerative forms of agriculture that prioritize long-term health and productivity over short-term gains.

3.1.4. Sub-theme 4: permaculture for landscape design

Flores and Buot (2021) have explored the structural characteristics and components of permaculture landscapes in the Philippines. They identified six zones (in line with Babac and Belic, 2018 study in 2018 which is discussed in Section 3.4) that are common across 12 permaculture sites. These zones provide a framework for designing more productive and diverse agricultural landscapes in terms of permaculture. Flores and Buot (2021) permaculture study emphasizes the potential of permaculture principles and practices in promoting sustainable agriculture, improving food security, and enhancing ecological resilience, particularly in small-scale farming communities in developing countries. Further to the environmental focus, the study also highlights the importance of incorporating local knowledge and practices into permaculture design to ensure cultural appropriateness and social sustainability.

Despite existing research illustrating the numerous benefits of permaculture from an environmental perspective as discussed in the sub-themes under Section 3.1, surprisingly, this approach is not often applied. According to interviews with 150 permaculture enthusiasts in Portugal, not a single permaculturist has been identified as an urban planner (Oliveira and Lopes, 2020) in their regions, even though urban planning is an influential intervention tool for integrating food planning approaches into urban systems. According to Maye (2018), one of the main reasons why permaculture is not fully integrated into a wider variety of disciplines (including urban planning) is that permaculture knowledge struggles to find a footing in agriculture, and this limits the crossing of disciplinary boundaries. Maye (2018) further argues that the limited interaction and intentional separation of the permaculture community from other agricultural philosophies partly explains the isolation of permaculture-agricultural integration, despite both focusing on food production.

3.2. Main theme 2: a social focus in permaculture research

A second main theme that has emerged from the literature scoping is the social perspective within permaculture. A social perspective for the purpose of this paper entails institutions, the general functioning of society, and the interactive relationships of different components within society. Several intervention notions have been researched and investigated as means to address social challenges, for example, hunger, poverty, unemployment, and inequality. The permaculture research conducted from a social focus, from 2015–2022, includes sub-themes regarding: (i) permaculture as a social movement (3.2.1), and (ii) permaculture as a social regeneration instrument (3.2.2).

3.2.1. Sub-theme 1: permaculture as a social movement

Permaculture is in its essence a grassroots initiative (a social movement) that is practiced from the bottom up by communities and NGOs (Ferguson and Lovell, 2015; Millner, 2016; Henfrey, 2018; Fadaee, 2019). However, unlike most studies, Fadaee (2019) study illuminates that permaculture as a social movement forms a part of the political society—on that premise, political intervention could directly equip marginalized communities to become more independent and self-sufficient. In most other studies on this stance, authors emphasize that there is a lack of intervention by scientific, political, and professional forces to support permaculture application in social systems and address contemporary global challenges, especially food insecurity (Ferguson and Lovell, 2015; Millner, 2016).

Aiken (2017) suggests that permaculture goes beyond adopting solutions for agricultural and ecological systems—they perceive permaculture as a facilitator of resilient communities and one that balances the interests of social and ecological systems. Ulbrich and Wostl (2019) present a more alternative interpretation of permaculture for social systems by introducing communities of practice (CoP) as an important social learning process. A CoP refers to a network of people who share similar interests, visions, ethics, and knowledge. These networks collaborate by participating in events and distributing expertise and experience to improve, grow, and develop social, cultural, and educational practices (Ulbrich and Wostl, 2019). Furthermore, Ulbrich and Wostl (2019) also noticed that NGOs are more inclined to adopt CoPs in their frameworks in the hope of enticing municipalities and decision-makers to endorse social development strategies. Consequently, these authors consider the permaculture community as a CoP for social innovation through learning opportunities.

3.2.2. Sub-theme 2: permaculture as a social regeneration instrument

Another aspect of permaculture that emerged from literature is its capability to regenerate social systems by addressing social issues such as food insecurity, poverty, violence, and health (Millner, 2016; Karim, 2018; Didarali and Gambiza, 2019). For example, a local study by Didarali and Gambiza (2019) reveals that seasonal

droughts posed an ongoing risk to many local farmers and their food production, which was partly the reason for permaculture adoption in Southern Africa. In the same study, permaculture is considered to have benefits for rural livelihoods, including improved nutrition from direct access to fruits and vegetables and the creation of additional work opportunities (Didarali and Gambiza, 2019). According to Millner (2016), political systems that focus solely on the "right to food" may overlook the social and environmental implications of mass food production. On the other hand, Didarali and Gambiza (2019) support the idea that designing agricultural systems with the ecological and social considerations of permaculture can offer solutions to a wide range of social challenges beyond just food insecurity, such as malnutrition. They argue that permaculture's emphasis on sustainability can lead to more equitable and resilient communities while still achieving the same benefits as larger-scale, comparatively costlier food production approaches.

Another example from literature is Karim (2018) study, which highlights the extreme violence in the Middle East and North Africa region caused by low living standards and underlying social and environmental frustrations among citizens. Hunger, water scarcity, and climate change conflicts often lead to violent outbursts. Karim (2018) proposes that permaculture can be a viable alternative to address these underlying issues that cause violence and unrest in underprivileged societies. By offering long-term food security, social inclusivity, and surplus sales income, permaculture can help alleviate the root causes of violence and provide sustainable solutions to communities facing these challenges. In this sense, Karim (2018) study supports the theme of permaculture as a regenerative social tool in literature.

Most of the literature highlights the low adoption of permaculture by small-scale farmers since there is a lack of permaculture training, education, knowledge, and awareness (Didarali and Gambiza, 2019). Awareness and understanding are especially lacking, not only in communities but also NGOs, professional disciplines, and government organizations that are emphasized in the literature. A few studies focused on raising permaculture awareness and improving the understanding of permaculture to improve community resilience through permaculture (Henfrey, 2018; Hinton et al., 2021; Spangler et al., 2021). Spangler et al. (2021) observe that the understanding and application of permaculture is extremely broad, and confusing, which often leads to its neglect within scientific communities. Interviews conducted in Spangler's study revealed the participants have varying understandings of permaculture and permaculture design and often confuse the two concepts/use them interchangeably. Permaculture design is considered to be concerned with the physical application of the design principles and recognized as more of a lifestyle approach and a way of thinking (Spangler et al., 2021). They also recognize that permaculture is frequently misunderstood and emphasize the importance of practitioners anchoring permaculture principles to promote its deeper integration into the design of healthy and equitable food systems.

In recent literature, Hinton et al. (2021) attest to the lack of permaculture awareness that also restricts its implementation in communities for example to borehole-garden permaculture (BGP), a method of permaculture implementation around public borehole waterpoints with the intent of utilizing and filtering stagnant infectious water that accumulates around these points (Rivett et al., 2018). Thus, their study envisions permaculture as a tool to address the health risk posed by these points, by utilizing the water to irrigate community food gardens (Hinton et al., 2021). However, only 43% of borehole communities were aware of BGP, and essentially only 2.4% implemented BGP. The study concluded that the reason for low awareness and application rate was social segregation, extreme poverty, limited financing, and lack of permaculture knowledge (Hinton et al., 2021). Hinton et al. (2021) suggest that NGOs and government organizations should take greater responsibility in promoting awareness and supporting the application and implementation of permaculture practices in communities in the future. Henfrey (2018) agrees by recommending that permaculture can be a useful transdisciplinary research tool to raise up resilient communities that can thrive independently from industrial food systems. Nevertheless, permaculture and its social benefits are often overlooked or oversimplified as a socioecological process because of its isolation, limited attention from scientific societies, and low awareness rate (Ulbrich and Wostl, 2019).

Finally, there is a visible need for intervention by professional disciplines, NGOs, and government organizations concerning permaculture. Ferguson and Lovell (2015) notably add that the responsibility of permaculture application and growth also lies with established permaculturists, who should help build institutional capacities and facilitate efficient efforts to raise awareness and promote democracy within social systems. While some attempts have been made to incorporate permaculture into professional and political knowledge, for example, permaculture application as a tool to regenerate social systems (Lapoutte, 2020), various other studies point out the importance of incorporating local knowledge and practices into permaculture design to ensure cultural appropriateness and social sustainability.

3.3. Main theme 3: an economic focus in permaculture research

In this study, business and economics have been combined in their approach to permaculture and entail the managing, coordination, and organization of business strategies as described by Akhtar et al. (2015) and Genus et al. (2021). This typically includes business management models, financial management, marketing, and trading strategies, among others. A body of literature has emerged from business and economic perspectives to address economic and management challenges through permaculture approaches as reviewed in the following paragraphs. The sub-themes that have emerged include (i) permaculture in business and market management systems (Section 3.3.1), and (ii) permaculture in economic systems (Section 3.3.2).

3.3.1. Sub-theme 1: permaculture in a business and market management system

Lapoutte (2020) studied the application of the permaculture management model as a tool to regenerate socio-economic enterprises that are under pressure from traditional management models, capitalism, professionalization, and isomorphism. Lapoutte (2020) concludes that implementing a permaculture perspective to regenerate social economy enterprises seem promising. Akhtar et al. (2015, 2016) studied permaculture as a tool to design management models to be sustainable from the onset, which they also found promising.

Akhtar et al. (2015, 2016) explore the integration of ecological sustainability into the business community through applying permaculture thinking. In their first paper, they explored the compatibility between permaculture and strategic management to achieve sustainability (Akhtar et al., 2015). In their research, Akjtar et al. integrated the 12 permaculture principles with the process of strategic management using a spiral integration tool. They found accordingly that for a management system that looks to integrate social and environmental factors, permaculture indeed supports suitable business management strategies (Akhtar et al., 2015). In their second paper, they explored how permaculture's ethics could assist strategic management agendas in the sustainable management of ecological resources (Akhtar et al., 2016). Recognizing that people's lives depend on the productivity of their lands, the researchers developed a management tool that monitors the social, economic, environmental, consumption, success factors, and sustainability of policy implementation to ensure that natural resources are not exploited and to decrease workload (Akhtar et al., 2016).

Vitari and David (2016) also researched the integration of permaculture principles in management models to achieve sustainability and more integrated economic, social, and environmental enterprises. They discovered a lack of in-depth research on the performance and results of permaculture-infused management models and suggested that permaculture as an alternative management model might be ideal for organizations in search of more forward-thinking and sustainable management models (Vitari and David, 2016).

3.3.2. Sub-theme 2: permaculture in an economic system

Genus et al. (2021) explores the integration of permaculture with institutional entrepreneurship and its effect on rising permaculture organizations. In the study, 20 interviews were conducted with permaculturists who started their own organizations and had created institutional biographies and portfolios (Genus et al., 2021). In line with the goals of King IV Report[8] on Corporate Governance IFOR South Africa (Institute of Directors in Southern Africa, 2016), their findings indicate the great potential of permaculture thinking to inform sustainable entrepreneurship and restructure business models into models that see beyond only "profit" entrepreneurship (Genus et al., 2021).

Interestingly, Jelinek (2017) states that sales management systems, nowadays, fail to identify and respond to substantial changes and shocks in the economic world and makes the connection that a permaculture perspective within these systems can empower sales organizations to be better able to withstand disturbances and shocks. Rocha (2022) contributes further by revealing that a permaculture approach to economic systems can indeed reveal innovative ways to pursue the consumption of natural resources and food production for capital growth more sustainably. He also states that this sustainable pursuit of natural resources would stimulate sustainable economic degrowth by which communities could rely less on industrialized food systems and transform food systems to be more sustainable and resilient and not depend on consumer-provider ploys (Rocha, 2022).

3.4. Main theme 4: permaculture from an urban planning and design perspective

To account for the lack of permaculture literature that incorporates urban planning perspectives, this study expanded its scope to include disciplines from the built/spatial environment. The built environment, as defined by Wilson and Piper (2010) and Pickett et al. (2013), encompasses all man-made communities, cities, and buildings, including residential areas, shopping centers, office buildings, and people. Relevant disciplines in this field include development management, urban planning, environmental management, architecture, and landscape architecture. Despite this, there remains a dearth of permaculture literature that specifically addresses urban planning, design, or other urban qualities, and as such, relevant papers were analyzed and reviewed to determine the extent of permaculture research from a built environment perspective. The only sub-themes that emerged from this theme include (i) permaculture to improve the efficiency of food systems (3.4.1); and (ii) permaculture knowledge to inform urban systems (3.4.2.).

3.4.1. Permaculture to improve the efficiency of food systems

Although permaculture is agricultural by nature, it is not as simple as applying its 12 principles. It should be a tool for designing food systems and dealing with the challenges within these systems that is based on ethical values and principles (Fiebrig et al., 2020). For instance, Babac and Belic (2018) research was conducted from an agricultural and mechanical engineering perspective, although their research itself directly regards zone planning. Specifically, they designed a layout for a permaculture system to minimize transport distance between the elements of a permaculture system and maximize efficiency. This system was informed by the mathematical formula, the triangular method. With this method, they generated a triangular layout in which, they recommend, all four zones are connected to Zone 0 (living quarters of humans) (Babac and Belic, 2018). Mollison (year) instead used a concentric circle zoning method to construct a permaculture

8 The King IV Code provides guidelines and principles for corporate governance in South Africa, emphasizing ethical leadership, sustainability, and the effective governance of organizations (Institute of Directors in Southern Africa, 2016).

system. In the concentric method, zone 0 has no connection with zones 2, 3, or 4, while in Babac and Belic (2018) method, zone 0 is directly connected to zones 1, 2, 3, and 4. Figure 4 illustrates the two zoning methods alongside each other. In illustration A of Figure 4; Zone 0 represents the living quarters of the humans, zone 1 represents crops that need frequent attention (a few times a day), zone 2 includes crops that require often visitation (once a day), zone 3 represents the main crops that are grown for household use and trade and require fewer visitations by humans (once a week), zone 4 represents a semi-wild area that requires little human visitations (once a month), and zone 5 represents wilderness or natural areas that require no human interaction. Ultimately, the triangular method proposed by Babac and Belic (2018) presents a design that minimizes the transport distance between the living quarters of people and each of the zones that require visitations. Although their study is still conducted within a rural setting, it could serve as a useful stepping stone for systems-thinking of permaculture within the built environment. At the very least it provides a good example of how the planning of permaculture systems can be explored more deeply. The issue of access as suggested here is highly relevant in the African context and South Africa.[9]

3.4.2. Permaculture knowledge to inform urban systems

Salleh et al. (2018) established the importance of local knowledge for designing permaculture systems and explored the impact of local knowledge (livelihoods, culture, and ecology) on permaculture planning and design. Akin to Babac and Belic (2018) study, Salleh et al. (2018) also highlight the permaculture zoning method based on the required interaction between nature and people. They state further that the success of a permaculture system largely depends on the local knowledge of a person to utilize the system positively or negatively and to apply the principles of permaculture. They establish that a permaculture system should be planned and designed with close consideration and observation of local knowledge and the local ecosystem to find the most suitable pattern and design for the system (Salleh et al., 2018).

Conducted from the built environment, architecture, and planning fields, Shaojie et al. (2019) study explored permaculture design on primary school campuses to educate youngsters about the natural environment by engaging them directly in such an environment. Through this engagement, children have been encouraged to participate in various activities while learning the importance and functioning of natural systems. Another driver behind this research theme could be translated to the need for an interconnected system in teaching. Here, they highlight that outdoor campus space has the potential to be integrated with indoor classroom teaching to broaden the teaching experience and learning abilities of children, all while providing the school with food (Shaojie et al., 2019). In contrast to Babac and Belic (2018) study, Shaojie et al. (2019) study takes another step closer to viewing permaculture as a food-growing practice within an urban setting and highlights the important potential of permaculture in an urban setting (food provisioning, learning landscapes, livelihoods, culture, and ecology).

Although the existing body of literature on permaculture from physical design and built environment perspectives is quite valuable, it has not been researched extensively enough to be duly considered and applied in the built environment as a tool to address urban food insecurity. With its brief presence in the built environment and spatial fields, permaculture research lacks the foundation needed for it to be utilized to its full extent in urban systems. Currently, the potential of permaculture research has been acknowledged marginally in spatial fields; however, it is too lacking in deep-rooted research and practical exploration of its position in urban systems for it to effectively address challenges regarding urban food insecurity and access to food. However, despite the limited presence in academic scholarship, practical examples (specifically on the African continent) where permaculture has been implemented successfully to address hunger do exist. Two primary examples are the food forests in Malawi (Moorsom, 2015) and the FTFA educational programme in South Africa (Food and Trees for Africa, 2023). A third example is the Chikukwa Project in Zimbabwe (Leahy, 2013).

4. Discussion

This scoping literature suggests that permaculture has significant potential in the key components of sustainability namely the social, environmental, and economic dimensions. However limited reference is made to the integration of permaculture in planning and design interventions, especially in urban contexts and how food systems can be included. The next section will synthesize the data and findings generated from this study to make recommendations for using permaculture to inform urban planning and design initiatives with special reference to urban food systems. A reflection is done on the themes, benefits, and limitations in the literature in relation to the integration of permaculture into urban systems.

Across all three dimensions—namely, the social, environmental, and economic realms—permaculture is examined as interacting elements of a design methodology aimed at rejuvenating deteriorated systems, whether they are environmentally compromised, socially impaired, or economically unproductive (Ferguson and Lovell, 2017; Grant and Yasue, 2017). This is done in contrast with other research on permaculture, where these three components are mainly treated in isolation from one another and thus lack the holistic integration that is necessary to function as an integrated sustainable permaculture system. In the planning for urban systems, it is essential to consider

9 South Africa is characterized by urban systems informed by the apartheid city where racial segregation was enforced and the movement and interaction between different racial groups were controlled. To his day, South African cities are characterized by marginalized sectoral areas that provide equitable access to the city centre, industrial zones, and residential areas that were formerly reserved for one race (Davies, 1981; Totaforti, 2020). The apartheid era led to segregated urban systems where low-income populations live in the city's periphery (townships), with limited access to business and industrial areas, economic opportunities and essential services, and the resources obtainable in the central business district (Cilliers and Jeeva, 2014; Mudau and Malatsi, 2022).

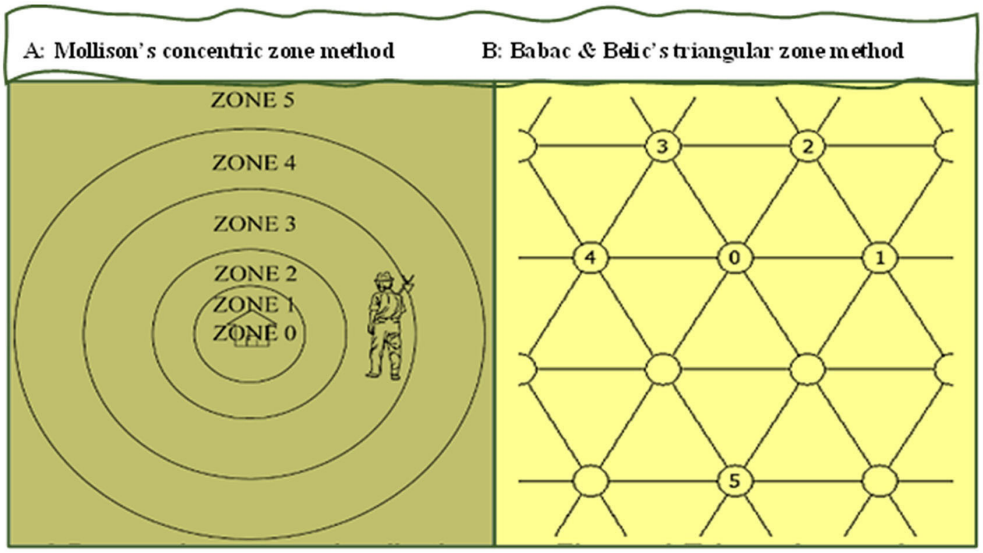


FIGURE 4
(A) Mollisons' concentric zoning method for a PC system. **(B)** Babac & Belic's triangular zoning methos for a PC system. Source: Mollison and Holmgren (1990) and Babac and Belic (2018, p. 106–108).

the social, environmental, and economic dimensions of urban systems as functional and whole environments for people to live in, while the purpose of a permaculture system is to provide food and ecosystem services to its components. This scoping review found that the primary themes (environmental, social, and economic perspectives) have featured strongly in permaculture scholarship in the past 8 years. The evidence suggests that the benefits of permaculture reach far beyond mere food provisioning (see Table 1 for a summary of these benefits). Two main aspects are noteworthy regarding permaculture literature across the main themes. First, the potential of permaculture to become an instrument for regeneration in various systems, including food systems; second, the flexibility of permaculture to be applied in different systems across various geographical contexts and on different scales while providing abundantly within the three components (environmental, social, and economic). These two characteristics will be elaborated upon in the next section with specific reference to the potential to inform urban planning of food systems, especially for contexts where high urbanization prevails, where urban land is available, and where food security remains a primary challenge.

4.1. Main conclusions

4.1.1. Permaculture as an instrument for regenerative urban systems

As a tool for regenerative food systems, permaculture represents a comprehensive and regenerative method of food production that is in line with the ideas of system regeneration and resilience. The idea of permaculture is to build self-sustaining and regenerative ecosystems by modeling food-growing systems after natural patterns and processes. Permaculture promotes soil health, biodiversity, and ecosystem services, all of which are essential for the renewal of food systems (see Section 3.1.2). Furthermore, permaculture methods endorse minimal soil disturbance, integrated cropping, agroforestry, and the utilization of organic matter, all being key factors in food production. Also, permaculture principles encourage waste reduction, effective resource use, and a thorough grasp of ecological relationships, which help produce food that is more resilient and sustainable (see Section 3.1.2).

In the context of urban environments, permaculture principles may well inform the design of productive and resilient urban food systems. Permaculture is emerging as a powerful tool to not only solve these concerns but also to actively regenerate food systems and promote long-term food security as the global food system faces increasing difficulties connected with urban growth. It is argued that due to the provision of fresh, locally sourced food, permaculture may potentially restore urban ecosystems and improve urban resilience by incorporating it as a regenerative and adaptable food-producing system. Permaculture design places a strong emphasis on resource management through techniques such as composting and rainwater harvesting, making it a useful tool for closing urban resource cycles (see Section 3.2.2). Permaculture promotes social cohesiveness and equips urban dwellers to take an active role in the development and regeneration of their local food systems through its emphasis on community participation and education (see Section 3.4.2). Although mostly studied in rural contexts, the characteristics of a permaculture system may potentially offer creative and sustainable approaches to developing regenerative urban food systems that are ecologically sound, socially inclusive, and economically viable in a time when urbanization and food security are serious issues.

TABLE 1 Value added by permaculture in all the dimensions.

	Value added through permaculture	Limitations of permaculture
Environmental	Ability to renature degraded land	Lack of engagement by professionals (urban planning)
	Broaden competence and autonomy	
	Regenerate soil health	
	Higher biodiversity	Lack of awareness in mainstream agricultural knowledge systems
	Provides ecosystem services	
	Produce food	
Socio-ecological	Recreate rural livelihoods	Lack of implementation in urban communities
	Improve rural livelihoods	
	Soil health - Composting - Recycling	Lack of intervention by professional forces
Social	Infuses transition for resilient community design	Lack of training and education
	Social learning process	
	Addressing social issues (poverty, violence, food insecurity, health, malnutrition, water scarcity)	
Socio-economic	Provide work opportunities	Lack of awareness and understanding in communities
	Generates income through surplus sales	
	Regeneration of socio-economic enterprises	
Business and economic	Tool for designing sustainable management models	
	Monitoring social, economic, environmental consumption (resource)	Lack of scientific research for integration
	Forward-thinking management models	
	Regenerate business models to see beyond profit entrepreneurship	
	More resilient and sustainable sales organizations	

Source: Author's compilation from findings.

4.1.2. Permaculture as urban planning instrument in regenerative urban systems—potential connections

A few characteristics of permaculture provide potential connections between urban planning and permaculture food systems:

(i) *Permaculture as an integrated design philosophy*: Permaculture encourages the use of an integrated design approach in the development of food systems. It emphasizes the peaceful cohabitation of people and nature and promotes the deliberate planning of space (although mostly referred to in rural contexts) that takes food production, green space, water management, and waste minimization into account (Oliveira and Lopes, 2020; Von Cossel et al., 2020; Flores and Buot, 2021). To design more sustainable and regenerative urban landscapes, urban planners might use permaculture concepts.

(ii) *Local food production:* Permaculture promotes the practice of local farming on various scales (Fiebrig et al., 2020; Flores and Buot, 2021). This may include food production in larger community gardens, smaller domestic gardens, school gardens, and even regenerating degraded urban spaces with the benefit of food production (Von Cossel et al., 2020; Hinton et al., 2021). These smaller-scale food systems can be incorporated by urban designers to boost regional food production, cut down on food miles, and improve urban dwellers' access to wholesome food.

(iii) *Biodiversity and ecosystem services*: Permaculture places a high priority on biodiversity and the development of ecosystems that offer a variety of functions and services (Oliveira and Lopes, 2020; Von Cossel et al., 2020). If permaculture can be incorporated into urban planning (e.g., parks, green roofs, underutilized space between buildings, and urban forests), it can provide food, promote biodiversity, deliver ecosystem services, enhance the quality of the air and water, and lessen the impact of the urban heat island.

(iv) *Resource efficiency:* Resource efficiency and waste minimization are stressed in permaculture concepts. Cities can be planned by urban planners to decrease resource usage and encourage techniques such as composting, recycling graywater, and rainwater gathering (Rivett et al., 2018). These

techniques not only lessen the environmental impact of cities but also support resilient urban food systems.

(v) *Community engagement:* Permaculture fosters community engagement, community empowerment, and participatory decision-making, which can be valuable in urban planning processes (Henfrey, 2018; Fadaee, 2019). Engaging residents in the design and management of urban food systems and green spaces enhances social cohesion and empowers communities to take ownership of their urban environments.

(vi) *Resilience*: Improving urban resilience is a goal shared by permaculture and urban planning and design. Cities can become more resistant to the problems posed by climate change, resource scarcity, and food insecurity by incorporating permaculture concepts into urban development.

In summary, although permaculture is not necessarily propagated here as a panacea to address food insecurity in highly and complex urbanized contexts (e.g., sub-Saharan cities), it does seem to offer a valuable point of departure where resource efficiency, community involvement, and sustainable food production may well be incorporated into urban food systems.

Urban planners may help create regenerative urban food systems that improve the quality of life for city dwellers while tackling urgent environmental and social issues by taking permaculture concepts into account.

4.1.3. Challenges for permaculture in urban contexts

Firstly, permaculture is often misunderstood in communities and professions mainly due to unfamiliarity and misinterpretation. One of the main reasons for the absence of permaculture in urban communities, scientific research, and professional disciplines is its connotation with rural practices and the lack of awareness regarding its capabilities to provide food and address other social issues within urban systems. South African towns are less densely populated in comparison to many other towns and cities in developing countries and offer ample underutilized open spaces (Smith, 2005). In some townships[10], for example, *The Masicendane Community Allotment Garden in Gugulethu* and *The Siyazama Community Garden in Khayelitsha*, *both in the Western Cape*, open spaces have been transformed into community vegetable gardens, and although these spaces do not conform to permaculture principles, they have the potential to do so (see https://www.farmersweekly.co.za/agri-business/empowerment/township-vegetable-garden-empowers-women/ & https://farmgardentrust.org/wp-content/uploads/2009/10/Community-gardens-breath-life-into-the-townships-Garden-Home-Mag-July-09.pdf).

Secondly, a common misconception that hinders the adoption of permaculture in urban environments is the belief that a significant amount of land is necessary for its implementation. Contrary to this notion, the earlier reference to Holmgren's original permaculture design principles, especially principle 9, emphasizes "small and slow solutions," indicating that permaculture can be applied effectively regardless of land size. Permaculture is adaptable in terms of its scale and extent, making it suitable for a range of urban settings, from high-rise apartments and residential gardens to open spaces between buildings and community gardens. Its application is diverse, involving private individuals, local authorities, and communities. Holmgren (2002) also clarifies that while the productivity and yield of a permaculture system may depend on its size, it is not restricted by it, as long as it is proportionate to the needs of its consumers.

A third challenge relates to the view of permaculture as a labor-intensive practice that requires constant human intervention, especially during its early stages (Babac and Belic, 2018). This reveals a possible restriction to its application by urban planning as it would require a great deal of time from the involved persons or immediate community to actively maintain, care for, and manage the permaculture system for it to essentially "bear fruit."

Finally, a challenge that specifically relates to the application of permaculture within urban planning initiatives is the extent to which planning policies, frameworks, and legislation endorse land use types that support permaculture practices or earmark specific areas in cities for urban food systems.

5. Synthesis, summarisation, and conclusion

The research in this paper stems from the call by the United Nations to end world hunger by 2030 (Sustainable Development Goal 2) and the need to address food insecurity which is a prevailing issue globally, especially in highly complex and urbanized sub-Saharan African countries. Permaculture, an integrative design system that mimics the patterns and processes found in natural ecosystems and requires minimal intervention by people, has the potential to establish food-producing ecosystems that, among other benefits, provide food sustainably. However, while permaculture has been researched from different disciplinary perspectives across a variety of global contexts, the focus is mostly on rural areas and limited research focuses on the African continent, where urbanization rates are extremely high. Subsequently, urban planning perspectives and the prospects for integrating permaculture in the sustainable planning of cities and communities (Sustainable Development Goal 13) remain a gap in permaculture research, especially relating to the potential of permaculture as an integrated food system to address food insecurity in urban communities. In this paper, a scoping literature review of permaculture was presented with the aim of considering the extent to which permaculture has been addressed in scholarship, taking cognisance of food insecurity and how permaculture can inform urban planning initiatives focused on food production in urban systems. It has been clear through the COVID-19 pandemic that generally our current food systems are too far from the point of consumption to be reliable in a crisis (Battersby and Watson, 2019; Fuseini and Sichone, 2019; Onyeaka et al., 2022). This begs the question: to what extent can cities and their hinterlands produce more of the food for urban consumption,

10 Townships are typically historically segregated residential areas that was created during the apartheid era (Davies, 1981; Mudau and Malatsi, 2022). Townships are mainly characterized by poor living conditions, limited access to basic services, food insecurity, and poverty (Totaforti, 2020; Mudau and Malatsi, 2022).

TABLE 2 Permaculture in an urban system.

Permaculture in the city	Permaculture ethics	Urban planning components	Benefits
Provide food to the immediate community	Care for the people	Social	Minimize transport costs
			Address social issues (hunger, violence, malnutrition, health, etc.)
			Social learning process
			Infuses transition for resilient community design
			Employment opportunities
Sustainable and regenerative use of natural resources	Care for the earth	Environmental	Provides ecosystem services
			Produce food
			Regeneration of degraded land
			Increased biodiversity
Improve economic growth in urban communities through the sale of surplus produce	Redistribution of the surplus	Economic	Income to workers
			Tool for designing sustainable management models
			Inspire others in the community to also start urban permaculture systems

Source: Own compilation.

and how can these be incorporated in the planning/design of cities? The scoping review presented here is argued to be a small step in the right direction of reconsidering how we plan for food security in sub-Saharan African cities and how planners may contribute to the ongoing global discussions on hunger.

Evidence from the scoping review strongly suggests that permaculture is a flexible system that promises excellent prospects to be utilized as a sustainable regenerative food system. It is argued here that these prospects may well be useful to consider for urban environments. The three dimensions of sustainability, namely, the environmental focus, social focus, and economic focus, have emerged as main themes from the scoping review with links to food systems and possibilities to utilize it as an integrated food production tool (see Table 2). It is recommended here that the prospects of permaculture to act as a regenerative and sustainable food system should be considered in areas (i) that need less sophisticated food systems (e.g., vertical gardens, aquaponics etc.,) (ii) that require little maintenance, (iii) with high population growth, and (iv) where a flexible, adaptable system (in terms of size and scale) may respond well to rapid changing urban environments such as cities of sub-Saharan Africa where food is not readily accessible and where resources (knowledge, skills, finances etc.) are low. Despite these prospects to create integrated sustainable regenerative urban food systems in the hope of achieving more sustainable inclusive cities and communities in African/sub-Saharan African cities, it is not offered as a panacea for food security on the African continent. The success and contribution of permaculture in sub-Saharan Africa to address food security are still questionable, and the extent of integration in the planning/design of cities has not yet featured strongly in academic scholarship. For these prospects to be realized, research should give careful consideration to how urban environments are planned/designed and integrated on policy and legislative levels with respect to permaculture.

Better awareness and understanding of permaculture and its role in urban food systems to address food insecurity is necessary if planners want to tap into the potential benefits of permaculture to create sustainable cities and communities. This requires planners to move beyond the consideration of traditional and sophisticated food systems in the planning of cities in sub-Saharan Africa and look for ways to incorporate permaculture in existing urban spaces.

The authors acknowledge that the selection criterion used in a scoping review may inadvertently skew the scope of the review toward Western-centric perspectives and academic publishing norms, potentially omitting important knowledge and experiences from diverse cultural and linguistic contexts in the global permaculture community. To mitigate this bias, future literature studies such as integrative or systematic literature reviews of permaculture scholarship should consider incorporating a more comprehensive and inclusive approach where diverse sources and languages are considered.

According to the scoping review discussed in this paper, permaculture is significant from an environmental, social, and economic standpoint. It can also be modified to be a beneficial tool for supplying a sustainable, regenerative urban food system. The many benefits of permaculture have been underlined in promoting sustainable food production, enhancing community resilience, and assisting in a more comprehensive approach that

might influence attitudes on urban development. Given the complexity of the urban food landscape, our findings indicate the need for additional study from an urban planning viewpoint to combat the Hunger Games that urban populations face in sub-Saharan countries/cities.

Author contributions

DJ did a comprehensive scoping review on Permaculture literature and wrote the review. KP made technical and structural changes to the article throughout the process and did the language editing. DJ and KP were hands-on involved with the article and gave constant input. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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