Urban Transformations

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A bibliometric analysis of urban food security

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Abstract

The study of urban food security has evolved dramatically over the past few decades. This evolution has been punctuated, and catalyzed, by insights into the dynamic transformation of food systems in cities. The evolution of this field, as revealed by its scholarly writings, provides an important vantage point for understanding both the dynamic transformation of the urban food system as well as the lens through which that transformation has been understood. This investigation adopted a bibliometric methodology, blending quantitative and qualitative analytical techniques, to assess the dynamic evolution of the literature over time. This methodology included a quantitative analysis of the metadata for 162 publications on urban food security. The results of this analysis provided an overview of research progress, historical and evolutionary trends, geographic disparities, keyword distribution, networks of collaboration, and key thematic foci. The quantitative analysis is complemented with a qualitative examination of top publications in the field. The results present a historical narrative of the evolution of urban food security research. In particular, the results indicate that the field has diversified its foci along key distinctions in food access and supply. The findings also identify common strategies and challenges inherent to the governance of urban food systems. In summary, this investigation provides a unique vantage point for discovering the evolution of urban food security and the perspectives that have defined that evolution.

Highlights

- The findingsindicate a diversification of research foci between food access and supply
- The studyidentifies a growing link between the fields of urban food security andsustainable urban development

Keywords: Urban food security, Bibliometric analysis, Urban food systems

Policy and PracticeRecommendations

- Urban foodsecurity may be better positioned from a sustainable urban development lensrather than an agricultural lens
- The urbanfood security field has evolved to support policies premised on support forfood access, beyond food supply
- Urban foodsecurity may evolve towards more wholistic sustainability policy discourse

Introduction

Food security, the stable access to enough safe and nutritious food to live a healthy life (paraphrased from FAO, 2008), has evolved with the complexity of modern global food systems. The concept of food security was born primarily within a national security framework (Clapp, 2015) with a focus on national self-sufficiency and agricultural productivity. Within this paradigm, food insecurity was caused by disrupted food supply, resulting in a risk to national security interests (Barrett, 2002; Jenkins and Scanlan, 2001). As a result, the main tools used to assess food security in this paradigm were derived from macroeconomic assessments of national food supply (Barrett, 2010).

Amartya Sen's (1980) seminal work on the causes of famine radically altered this paradigm. Sen proposed that food insecurity was not necessarily the result of disrupted supply but of disrupted access (Sen, 1981). In particular, he noted through case studies of historical famines that insufficient entitlements were the ultimate root cause of food insecurity. Furthermore, Sen argued that locus of the food security debate should not be established via nationally aggregated statistics but by individually disaggregated characteristics. Sen's arguments opened the door to a diversity of approaches and conceptualizations of food security.

Since the work of Sen, novel approaches to food security research have begun to integrate broader themes from complex systems dynamics (Barrett, 2002; Ecker and Breisinger, 2012). These approaches have integrated the notions of risk, multi-scalar interactions, and system resiliency in the discussion of food security. As conceptualizations of food insecurity growingly embrace ideas generated from complex adaptive systems (Holland, 1992; Meadows and Wright, 2008), innovative approaches to understanding the risks, hazards and opportunities of food systems have emerged (Fraser, 2006; Ericksen, 2008). These approaches have broadened the scholarly understanding of how food security is maintained in an evolving global food system.

One emerging area of research has focused on food security in the context of cities. This urban food security approach has been driven by the need to address issues of urban poverty (Haddad et al. 1999; Maxwell, 1999; Satterthwaite and Mitlin, 2012). The rising incidence of poverty and malnutrition in cities is part of a larger urbanization of the Global South (United Nations, 2015), driving livelihoods towards novel and, at times, precarious avenues of income generation (Amis, 1995; Godschalk, 2003). This transition is occurring in a global food system where up to 30% of food is never consumed (Crush and Frayne, 2011a, b; Godfray et al. 2010) and diets have

transitioned to an unsustainable consumption of meats and dairy under the strain of climate change (Godfray et al. 2010; Brown and Funk, 2008).

As a result of these pressures, and the new conceptual flexibility afforded by an evolving understanding of food security, the field of urban food security has been growing steadily as a research focus over the previous decade (Crush and Frayne, 2011a, b; Battersby, 2013). The field has also bifurcated into two foci: one focused on supply-side dynamics (focusing in particular on issues of urban agriculture, supermarketization and the informal food system) and one focusing on household food access (under the strains of household poverty, public health issues, rising food prices, infrastructure access). The supply-side dynamics of urban food security has produced varied empirical support for the importance of urban agriculture in the maintenance of food security (Zezza and Tasciotti, 2010; Frayne et al. 2014; Orsini et al. 2013; De Bon et al. 2010). Studies on the growing dominance of supermarkets in urban food systems have highlighted their implications for household food access, food sourcing, and dietary diversity (Crush and Frayne, 2011a; Reardon and Hopkins, 2006; Battersby and Peyton, 2014). At the same time, there has been a growing interest in the contributions of the informal economy to the maintenance of household food security in terms of food supply and employment (Battersby and Marshak, 2017; Skinner, 2008).

Studies focusing on urban household food access have taken diverse approaches to the topic. Many of these studies have explored the link between household food security and household poverty (Maxwell, 1999; Tawodzera et al. 2016). Other studies have focused on the urban food security impacts of infectious diseases (Crush et al. 2011a, b) and the relationship between urban food security and non-communicable diseases (Smit et al. 2016; Demmler et al. 2017; NCD-RisC 2019). The 2010 Food Price Crisis catalyzed several studies on the impact of food prices on urban food security (Cohen and Garrett, 2010; Sonnino, 2016). In addition to these diverse approaches and foci, there have also been novel approaches linking urban food security broadly to urban planning and infrastructure access (Pothukuchi and Kaufman, 1999; Morgan, 2013; Frayne and McCordic, 2015).

Much of this research has coalesced around, and challenged, the evolution of the urban food desert concept (which has been forced to come to terms with non-western characteristics of urban food security). Since its inception in the 1990's in the United Kingdom (Beaumont et al. 1995), the food desert concept has attempted to formalize the observation that food may be more difficult to access in some urban areas than in others (Wrigley et al. 2003). This concept was originally measured according to the distance between households and supermarkets (D'Rozario and Williams, 2005), but soon focused on the types of food accessed by households and food consumption behaviours in general (Beaulac et al. 2009; Bridle-Fitzpatrick, 2015). Since 2010, however, the concept has been forced to evolve to consider economic, social, and political factors that influence food access (Horst et al., 2016; Sadler et al. 2016; Shannon, 2016). This paradigm evolution was forced, in part, by emerging urban food security research from the Global South which questioned both aggregated spatial measures of food availability and broadened the diversity of food sources originally outlined by Western notions of urban food deserts (Battersby & Crush, 2014).

The urban food security field has undergone seismic paradigm transitions over the course of its evolution. Given the rise of food insecurity in cities, this field of research is

set to play an important role in shaping future municipal food policies. Understanding the historical evolution and future directions of the field can provide insight into how those policies may be shaped by future prevailing urban food security research. Unfortunately, there is little research to document the evolution of those urban food security paradigms and to project the next steps in the field's evolution. The purpose of this paper is thus to identify the key concepts and paradigms that have defined our understanding of urban food security and to document the evolution of the field. The bibliometric method is particularly well suited for this purpose, as an objective measure to evaluate scientific literature in a manner than increases rigor and mitigates research bias (Zupic & Čater, 2015; Sweileh 2020). This manuscript responds to this research gap by implementing bibliometric analysis to understand the evolution of the urban food security field through an analysis of research progress in the field, the influential publications in the field, and the dominant themes in the field via a content analysis.

Methodology

Research questions

1. Which authors, journals, and institutions most influenced urban food security research? (Research progress).
2. How have the influential publications in the field shaped our understanding of urban food security? (Influential publications).
3. How have the conceptual building blocks of the urban food security field evolved over time? (Content analysis).

Data

The purpose of this research is to get a sense of how the urban food security field has evolved over the past 30 years. This selected timeline accounts for the majority of urban food security publications based our analysis of the publication timeline in the field (Fig. 1).

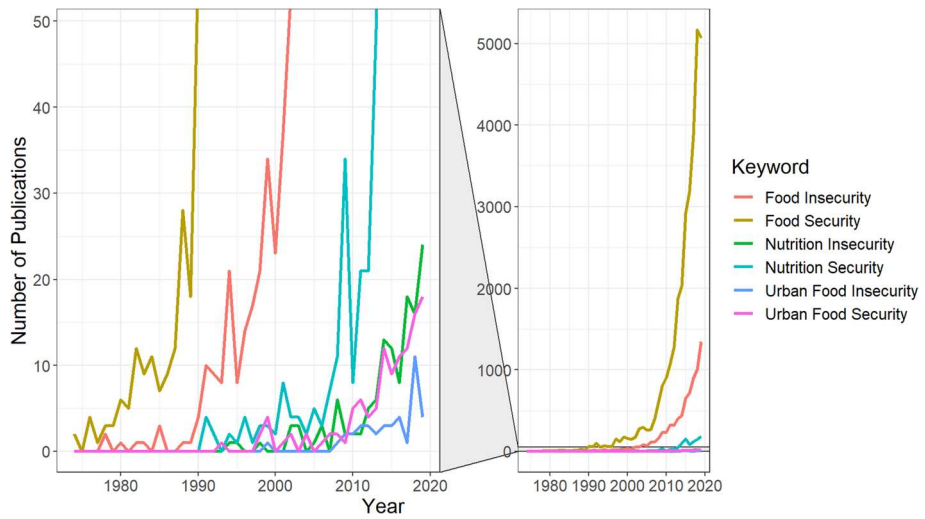

Fig. 1 Number of publications on Web of Science and Scopus for each topic (figure on the right is an enhanced image of the relevant section of the image on the left)

In identifying our final sample, we apply the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses' (PRISMA) (Moher et al. 2009). Our process is as follows. Bibliometric information of journal articles were retrieved from the Web of Science database and Scopus via a systematic search of academic literature relating to iterations of urban food security. The associated queries[1] resulted in 362 journal articles. Three screening measures were applied to identify relevant articles; the document type was restricted to articles, the language was restricted to English, and the timeline was restricted to pre-2019. Finally, duplicates were removed. This resulted in a final sample of 162 journal articles on urban food security. Metadata, including authorship, journal, and abstract among others, were exported as a Bibtex file in March 2020. The following query was used to sample the 162 journal articles included in the analysis:

> *TITLE+ABSTRACT+KEYWORD("urban food security" OR "urban nutrition security" OR "urban food and nutrition security" OR "urban household food security" OR "urban household nutrition security" OR "urban household food and nutrition security" OR "urban food insecurity" OR "urban nutrition insecurity" OR "urban food and nutrition insecurity" OR "urban household food insecurity" OR "urban household nutrition insecurity" OR "urban household food and nutrition insecurity")*

Analysis

Bibliometrics has a deeply established history (Pritchard, 1969) as a process by which to objectively analyze a body of literature. Research adopting the bibliometric methodology has undergone rapid uptake in recent years, with over 55 percent of all bibliometric studies published since 2015. In other words, over half of all studies that have relied on bibliometric analysis have only recently been published (since 2015). The over 12,000 sources indexed by Web of Science and Scopus span disciplinary boundaries, from computer science to management, medicine, and environmental studies. Advancements in computing capabilities and the development of software tools (Aria & Cuccurullo, 2017; McLevey & McIlroy-Young, 2017; van Eck & Waltman, 2010) have facilitated faster more comprehensive analyses on increasingly larger datasets.

In contrast to a traditional systematic review, bibliometrics describe the structure of scientific literature (Nakagawa et al. 2019), using quantitative analysis to study publication patterns based on the article's metadata. Metadata analysis can be descriptive, such as how many articles have been published, or who are the top authors, journals, institutions, and keywords. Or it can be evaluative, examining how select authors, articles, journals, or institutions have influenced subsequent research by others. Bibliometrics are thus better suited to document and visualize the evolution of a field of study and consequently, the trends and opportunities for future research. As such, it has benefited greatly from advances in big data, visualization, text mining, and network analysis.

[1] "urban food security" or "urban nutrition security" or "urban food and nutrition security" or "urban household food security" or "urban household nutrition security" or "urban household food and nutrition security" OR "urban food insecurity" or "urban nutrition insecurity" or "urban food and nutrition insecurity" or "urban household food insecurity" or "urban household nutrition insecurity" or "urban household food and nutrition insecurity".

The analysis presented in this paper was conducted using the open-source R software (version 3.6.2) and several notable packages including Bibliometrix (Aria & Cuccurullo, 2017), Tidytext (Silge & Robinson, 2016), and ggplot2 (Wickham, 2009). We follow the five-step workflow developed by Zupic and Cater (2015) to conduct the bibliometric analysis. Specifically, we determined our research question, compiled relevant data, analyzed the data, visualized the findings, and interpreted the results. In the case of this investigation, our research questions focused on assessing the research progress, influential publications, and content of the collected urban food security literature.

This investigation assessed research progress in the urban food security field via annual trends in publications. These trends were analyzed by counting the number of publications in the Web of Science and Scopus that included the previously specified keywords used in the search queries to shape the sample for this investigation. This analysis also counted citations accrued over time for the journal articles collected, the geographic distribution of authors of the collected journal articles and the affiliations of those authors.

The investigation assessed influential publications in the corpus of collected literature by determining the most cited journal articles within the sample. The assessment also identified the most cited authors within the collected literature and calculated the collaboration index for the collected literature (the average number of co-authors per publication across all multi-authored articles). This assessment also included Reference Publication Year Spectroscopy (RPYS) to assess influential publication. The RPYS method assesses the extent to which the citations accrued for each publication deviates from the median number of citations received by the publication over a 5-year period (2 years prior, current year, and 2 years after). The analysis produces a RPYS graph where publications with high scores deviate significantly from the median number of citations. This analysis identifies influential years for the collected publications.

Finally, the investigation carried out a content analysis of the collected literature by assessing the frequency of words used in the abstracts of the collected journal articles. This analysis also assessed the frequency of word pairings (words that frequently appear together) in the journal article abstracts as well as keyword co-occurrences listed in the collected journal articles. This analysis also included strategic diagrams which map the centrality of keywords (the extent to which certain keywords occur together with other keywords within publications) and density (the extent to which certain keywords occur across publications). Strategic analysis allows for an analysis of themes using these two dimensions (centrality and density), where centrality indicates the degree to which themes are connected with other themes in the literature and density indicates themes that frequently appear in the literature. While this content analysis only focuses on the themes in the publications (based on the abstract and keywords), a deeper analysis of the content in influential journal articles in the field has been provided with the analysis of influential publications.

Limitations

The analyses carried out in this manuscript are limited to the search criteria used in the methodology. As a result, the generalizability of the findings from this investigation are necessarily limited to the parameters set by these search criteria. Furthermore, the metrics used in this analysis were exclusively drawn from Web of Science

and Scopus. We note some limitations to this method of data collection. Several notable publications such as Sen (1981) are not included through these scoping criteria. Additionally, the restricted search queries do not comprehensively capture adjacent but relevant fields of study, like that of urban supermarkets, urban informal food systems, and urban food deserts.

Results

Research progress

Literature on urban food security is niche and nascent relative to the body of literature on food and nutrition security (Fig. 1). As of December 2019, there were a total of 31,819 publications on "food security" indexed to the Web of Science and Scopus, dating as far back as 1974. Moreover, 27,386 (86 percent) of publications on "food security" were published between 2010 and 2019, with an average 22.1 percent year over year growth. This attests to the rapid growth of literature on "food security". We also examined the publication trends of "food insecurity", "nutrition security" and "nutrition insecurity". "Food insecurity" is the second most prevalent keyword, but is dwarfed in comparison to "food security" with a total of 7,437 publications indexed to the Web of Science and Scopus. This is followed by nutrition security with 984 publications and nutrition insecurity with 127 publications. There is notable lag in both food and nutrition literature where discourse on insecurity appears several years after discourse on security. In other words, the early literature tended to discuss food *security* in cities, however, over the years the literature has shifted towards discussing food *insecurity* in cities.

Urban food security and insecurity comparably have 116 and 41 indexed publications on the Web of Science and Scopus respectively. Thus, "urban food security" accounts for less than 0.004 percent of 31,000 publications on food security that were identified by this study. This attests that literature on urban food security is a relatively niche field within the larger discourse on food security. Moreover, the first publication on "urban food security" indexed to the Web of Science and Scopus is from 1993, 19 years after the first indexed publication on "food security". This attests that literature on "urban food security" is also relatively nascent in relation to "food security".

Nevertheless, the topic of urban food security has undergone a consistent level of growth in publication numbers over time (Fig. 2a), increasing from just 11 publications in 2000 to 162 by 2019. 85 percent of publications in the sample are published after 2010. There is a notable dip in related publications from 2015 to 2017, which may warrant further analysis. Still, the rapid uptake in related publications attests to the enormous interest the field has garnered in recent years. In addition to the publication counts, research progress may be also measured in total citations (Fig. 2b). Total citations to date surpass 2,900, indicating an expanding accumulation of knowledge about urban food security.

The analysis also considered the country where authors of the 162 publications were based (the country of their institutional affiliation). By region, the most prolific publishers are from the United States, Canada, and South Africa. However, cross-country partnerships are on the rise (Fig. 3). As an example, scholars from Ethiopia, Malawi, Ghana, South Africa, Kenya, and Sierra Leone networked extensively with European

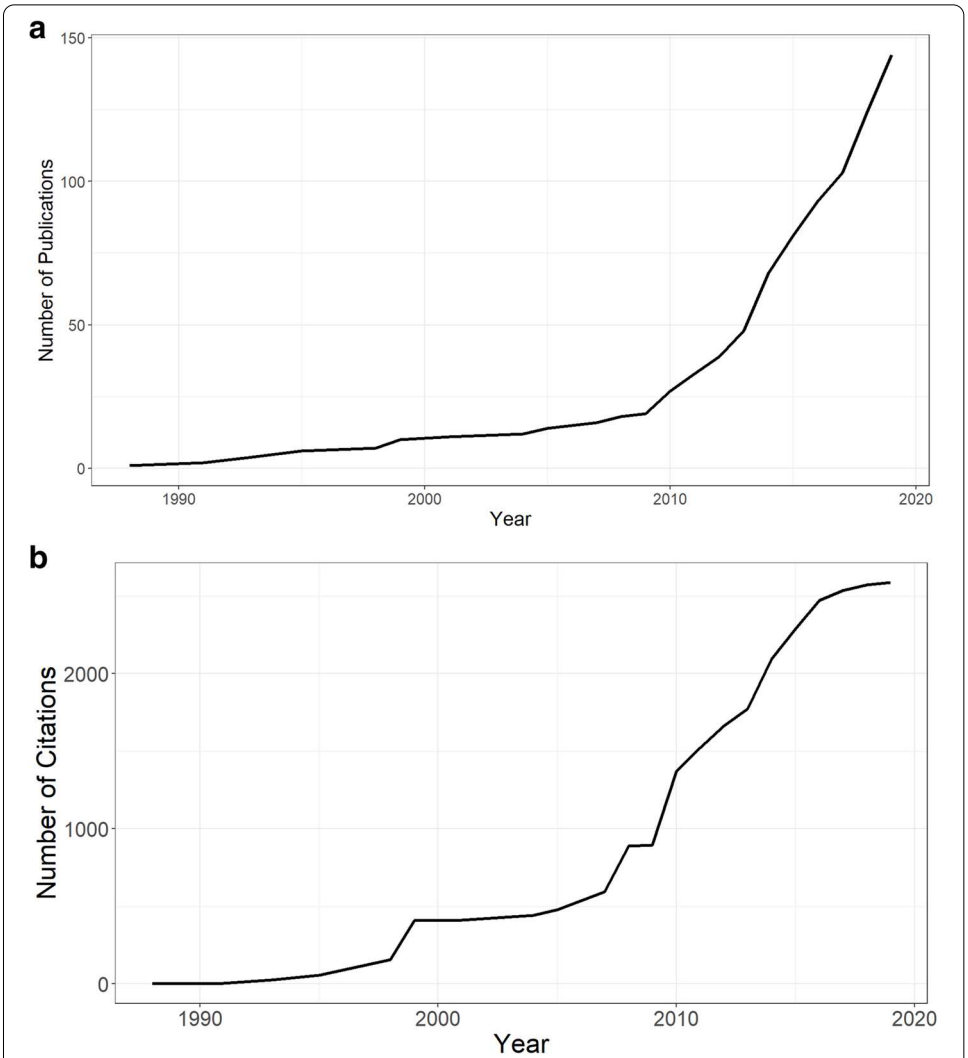

Fig. 2 a Publications over time. b Total citations over time

and North American scholars on urban food security investigations. The average number of countries per publication increased from 1 to 2.6 over the period of analysis, indicating more frequent international cooperation in food security discourse. In all, we identify a total of 27 countries represented in this body of literature. Institutionally, the University of Cape Town, South Africa is among the most active with 24 publications. This is followed by the University of Waterloo, Canada and the Balsillie School of International Affairs, Canada with 10 and 8 publications respectively.

Influential publications

We identify 345 unique authors in the collected literature, however, 290 (84 percent) have only published one paper on the topic. Among the most prolific authors in the dataset is Jonathan Crush, Jennifer Battersby, and Bruce Frayne, contributing to 9, 8, and 8 publications respectively. The analysis also revealed extensive author collaborations over time. The collaboration index (Elango and Rajendran, 2012; Koseoglu, 2016)

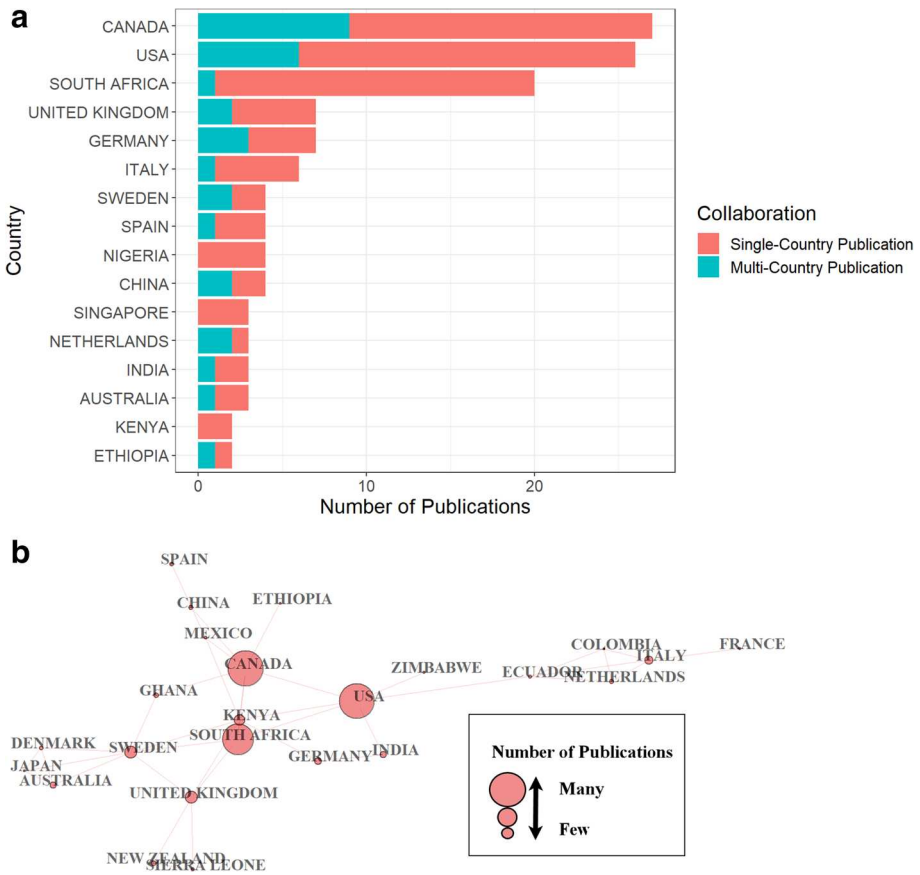

Fig. 3 a Publications by region. b Network of regional collaborations

calculates the average number of co-authors per publication across all multi-authored articles. Within the collected literature, the collaboration index has risen from 2 to 4.87 over the past 30 years. By journal, Urban Forum, Food Security, Food Policy, and Sustainability are among the most prominent sources in this dataset, together accounting for 40 (24.7 percent) of the 162 publications in the dataset.

To gain a comprehensive understanding of the most influential papers in the field, we examine the top manuscripts by citation count and the top cited references within the collected journal articles. First, we begin by analyzing manuscripts in the dataset, by citation count (Table 1). The analysis focused on the citation count for the publications based on metrics from the Web of Science and Scopus, however, the Google Scholar citations for these publications (at the time of writing this manuscript) have been included as well. It is important to note that total citation count does favor older publications. Thus, we also examine any additional publications with a high number of citations per year (Table 2). This table shows more recent influential publications and notably no single publication appears on both lists which might indicate that the influence of the publications in Table 1 is waning.

Guthman (2008) was the most highly cited journal article in our corpus and this paper discussed the emerging area of alternative food practices. Short et al. (2007)

Table 1 Top publications by times cited

Publication	Times Cited	Citations per year	Google Scholar
Guthman J (2008) Bringing good food to others: Investigating the subjects of alternative food practice. Cultural geographies 15(4): 431–447	284	25.8	804
Zezza A & Tasciotti L (2010) Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries. Food Policy 35(4): 265–273	229	25.4	811
Vermeulen SJ, Aggarwal PK, Ainslie A, Angelone C, Campbell BM, Challinor AJ, … and Wollenberg E (2012) Options for support to agriculture and food security under climate change. Environmental Science & Policy, 15(1): 136–144	159	22.7	399
Short A, Guthman J, and Raskin S (2007) Food deserts, oases, or mirages? Small markets and community food security in the San Francisco Bay Area. Journal of planning education and research, 26(3), 352–364	112	9.3	295
Ellis F, Sumberg, J (1998) Food production, urban areas and policy responses. World Development 26(2): 213–225	98	4.7	321

Table 2 Top publications by citations per year

Publication	Times Cited	Citations per year	Google Scholar
Opitz I, Berges R, Piorr, A, Krikser T (2016) Contributing to food security in urban areas: differences between urban agriculture and peri-urban agriculture in the Global North. Agriculture and Human Values 33(2): 341–358	64	21.3	235
Russo A, Escobedo FJ, Cirella GT and Zerbe S (2017) Edible green infrastructure: An approach and review of provisioning ecosystem services and disservices in urban environments. Agriculture, Ecosystems & Environment, 242: 53–66	36	18.0	119
Orsini F, Kahane R, Nono-Womdim R, Gianquinto G (2013) Urban agriculture in the developing world: a review. Agronomy for sustainable development 33(4): 695–720	75	15.0	433
Badami MG, Ramankutty N (2015) Urban agriculture and food security: A critique based on an assessment of urban land constraints. Global Food Security 4: 8–15	58	14.5	194
Warren E, Hawkesworth S, and Knai C (2015) Investigating the association between urban agriculture and food security, dietary diversity, and nutritional status: A systematic literature review. Food Policy, 53: 54–66	42	10.5	119

discussed the emerging area of alternative food practice as well. Both of these papers respond to narratives of food justice and activism initiatives aimed at increasing food access in African American communities or food deserts. Results show a low uptake of such initiatives by communities reflecting a general disconnect between the proponents and recipients. Alternative food practice is still underpinned by whitened cultural perspectives rather than those of the objects in communities being served (Guthman, 2008). Additionally, alternative food sources in all low-income communities are unevenly distributed catering more for the needs of immigrant (African American, Latino) neighborhoods rather than all residents (Short et al. 2007).

Other publications in Table 1 focused on the rising incidence of poverty and food insecurity in cities of developing countries and how urban agriculture (UA) might provide

an effective means of addressing these challenges. UA is portrayed as capable of contributing to food security in urban areas by supplying high-quality vegetables and animal produce, in proximity to poor urban households (Ellis & Sumberg 1998; Zezza & Tasciotti 2010). The publications were however skeptical about how beneficial UA is for addressing both food insecurity and poverty. Reasons provided are that UA is practiced by established residents and not the newest or poorest urban residents due to lack of access to land or restrictions from municipal byelaws (Ellis & Sumberg 1998; Zezza & Tasciotti 2010). Additionally, Ellis and Sumberg (1998) noted that UA does not consider the role played by rural–urban interactions in the survival capability of the urban poor. Vermeulen et al. (2012) also introduced a more recent focus on how urban and rural agriculture are contributory and vulnerable to both climate change and climate change impacts on food security and food systems.

The top publications by citations per year (Table 2) discuss the impacts of UA and its typologies on food and nutrition security (Opitz et al. 2016; Badami & Ramankutty, 2015; Warren et al., 2015; Orsini et al., 2013 & Russo et al. 2017). The most cited publication per year Opitz et al., (2016) discussed addressing urban food insecurity using UA from a Global North perspective whilst defining peri-urban agriculture (PUA) as an aspect of UA. In recognition of rapidly expanding urban settlements PUA is described as agriculture on the fringes of urban areas. Apart from contributing to food security UA and PUA in the Global North provided a profession, recreation, supplemental income, health and community development unlike the Global South where it is mostly for subsistence (Opitz et al., 2016). Badami & Ramankutty, (2015) reviewed scenario analyses which indicated that some high-income countries in Europe and North America could produce more vegetables than they require by devoting less than 3% of urban land to food production. By contrast, these scenario analyses demonstrated that some low-income countries in Sub-Saharan Africa would require more than 100% of the urban land available to grow sufficiently to meet their vegetable consumption needs.

Orsini et al. (2013) and Russo et al. (2017) address the challenge of land availability for UA by researching new strategies for food supply using roof top gardening and edible green infrastructure. Urbanization drives land-use changes with huge carbon dioxide emissions. As such, rooftop vegetable gardens, and edible green infrastructure typologies (edible urban forests, school gardens, allotment gardens, home gardens) can provide avenues for fresh vegetables and mitigate climate change (Orsini et al., 2013; Russo et al. 2017). For example, Orsini et al. (2013) estimate that converting the total area of rooftops in Bologna to urban gardens could produce 77% of the city's vegetable requirement.

The papers reviewed in Table 2 indicate a transition towards recent interconnections between urban food security and planning, urbanization, edible green infrastructure, climate change and sustainability. Based on these papers there seems to be little evidence in support of UA from a Global South context or perhaps the pathways by which UA influences urban food security in the Global South appears to be more complex than is seen. Warren et al. 2015 suggest incorporating better study designs and evaluating UA programs to understand the impact on urban food security.

To address one of the limitations of this method, the restricted sample, we also examine the most highly cited papers within the citation lists of articles in our sample. In examining which papers are frequently cited by those in our sample, we can

identify influential publications that are crucial to the field but may fall outside of our query or publication type. The 'times cited' column thus refers to the number of articles in our sample, that reference that publication. Articles that are unique to this table have influenced the field of urban food security, however, may include books, technical reports, or topics adjacent to our query. These papers complement those from Table 1 highlighting the need for multi-pronged approaches for addressing urban food insecurity. Examining the cited references of key urban food security publications can illuminate the conceptual building blocks for those key publications. Table 3 presents the most frequently cited work by the publications within the sample.

Perhaps it is no surprise that Urban agriculture (UA) is a common theme among the most highly cited urban food security research papers. Zezza & Tasciotti (2010) were by far the most highly cited in these papers. These authors conducted a comparative analysis of household survey data for 15 developing or transition countries, to determine the importance of UA for the urban poor and food insecurity. The findings of this paper, however, indicated that UA has a limited correlation to income contribution and overall agricultural production for urban households (Zezza & Tasciotti, 2010; Crush et al. 2011a, b). Urban food security measurements, such as the Household Food Insecurity Access Scale (HFIAS), can support the conceptualization of food challenges experienced by urban dwellers, however, it is difficult to quantify and classify by a singular scale due to the multidimensional nature of food security (Coates et al. 2007; Maxwell et al. 2014).

Another common theme among these frequently cited papers was the new international food security agenda. This agenda highlights the apparent international emphasis on small-scale rural agriculture production in food security interventions, rather than the growing implications of urban food insecurity (Crush & Frayne, 2011a, 2011b). At the time of writing, the authors noted that there was limited research exploring the implications of formal-informal food systems and urban food security (Cohen & Garrett,

Table 3 Top cited references outside of the sample

Publication	Times Cited	Google Scholar
Zezza A & Tasciotti L (2010) Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries. Food Policy 35(4): 265–273	14	811
Coates, J., Swindale, A. and Bilinsky, P. (2007) Household food insecurity access scale (HFIAS) for measurement of household food access: Indicator guide (Version 3). Washington, D.C.: Food and Nutrition Technical Assistance Project	11	1352
Crush J, Frayne B (2011a) Supermarket expansion and the informal food economy in Southern African cities: Implications for urban food security. Journal of Southern African Studies 37(4): 781–807	9	232
Battersby J (2011) Urban food insecurity in Cape Town, South Africa: An alternative approach to food access. Development Southern Africa (Sandton, South Africa) 28(4): 545–561	8	145
Cohen M, Garrett J (2010) The food price crisis and urban food (in)security. Environment and Urbanization 22(2): 467–482	8	439
Crush J, Hovorka A, Tevera D (2011) Food security in Southern African cities: The place of urban agriculture. Progress in Development Studies 11(4): 285–305	8	243
Crush J, Frayne B, Pendleton W (2012) The Crisis of Food Insecurity in African Cities. Journal of Hunger & Environmental Nutrition 7(2–3): 271–292	8	116
Crush J, Frayne B (2011b) Urban food insecurity and the new international food security agenda. Development Southern Africa 28(4): 527–544	8	206

2010; Crush & Frayne, 2011a). The authors also noted how supermarkets may displace informal food vendors in many cities, removing an important food source for poor urban households (Cohen & Garrett, 2010).

There is an overlap between the top publications (Table 3) that cite a food security survey conducted in eleven cities in Southern Africa by the African Food Security Urban Network (AFSUN) to conduct a comparative analysis of qualitative findings (those overlapping references include Battersby, 2011; Crush & Frayne, 2011b; Crush et al. 2012). The findings of this research indicated that a key driver of food insecurity in poor urban households in the increasing inaccessibility and unaffordability of food (Battersby, 2011). These publications note that food is the largest expenditure of the urban poor (Cohen & Garrett, 2010; Crush & Frayne, 2011b). Additionally, the authors note that urban poor access food through informal food systems where food is purchased more frequently and in smaller quantities with higher prices (Cohen & Garrett, 2010; Crush & Frayne, 2011a). Additionally, these publications discuss the synergistic and conflicting relationship between supermarkets and informal food vendors in cities (Cohen & Garrett, 2010; Crush & Frayne, 2011a; Crush et al. 2011a, b). Within this discussion, the authors note that informal food systems tend to be more accessible and affordable to poor urban households (Crush & Frayne, 2011a; Crush et al. 2011a, b).

Finally, a standard reference publication year spectroscopy (Marx et al., 2014) can better examine the genesis and evolution of publications in the field, by identifying foundational years (and their respective publications) beyond our sample. The RPYS (Fig. 4) examines abnormal deviations from a 5-year rolling median of cited references, to identify notable years that has made a significant contribution to the body of literature. Table 4 highlights the top paper from each of the seminal years identified. The median score column refers to the deviation of the number of cited references from the median over 5 years; the greater the number, the more influential that year was for the respective topic. 2010 was one such seminal year, along with 1996 and 2000 (Fig. 4).

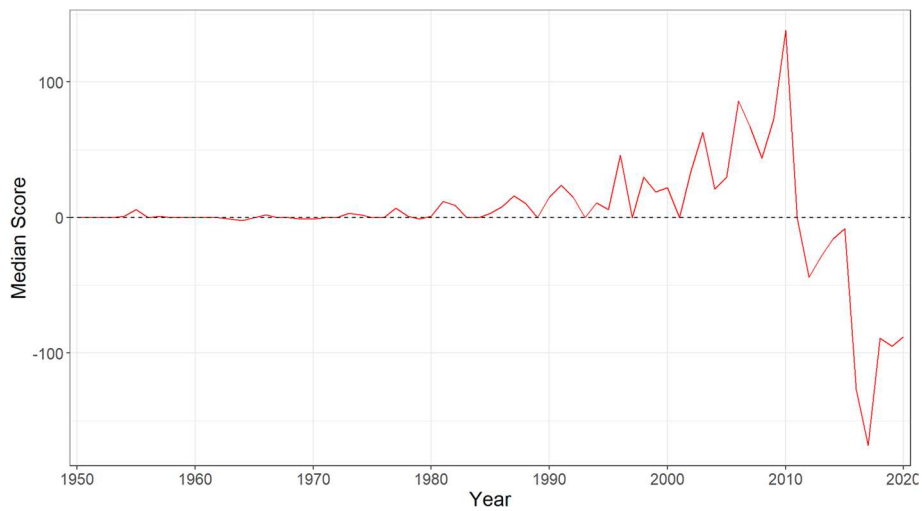

Fig. 4 Reference Publication Year Spectroscopy

Table 4 Standard Reference Publication Year Spectroscopy (RPYS)

RPYS Year	Median Score	Publication	Times Cited
2010	97	Cohen M, Garrett J (2010) The food price crisis and urban food (in) security. Environment and Urbanization 22(2): 467–482	8
2010	97	Lee-Smith, D (2010) Cities feeding people: an update on urban agriculture in equatorial Africa. Environment and Urbanization, 22(2): 483–499	7
2010	97	Morgan K (2013) The rise of urban food planning. International Planning Studies 4: 341–348	6
1996	30	Maxwell S (1996) Food security: a post-modern perspective. Food policy, 21(2): 155–170	2
1996	30	O'Kelly M and Bryan D (1996) Agricultural location theory: von Thunen's contribution to economic geography. Progress in Human geography, 20(4): 457–475	2
1996	30	Smit J, Nasr J, and Ratta A (1996) Urban agriculture: food, jobs and sustainable cities. New York: Urban Agriculture Network Inc	2
2000	21	Pothukuchi K and Kaufman JL (2000) The food system: A stranger to the planning field. Journal of the American planning association, 66(2): 113–124	6
2000	21	Goldman A (2000) Supermarkets in China: the case of Shanghai. The International Review of Retail, Distribution and Consumer Research, 10(1): 1–21	3
2000	21	Veeck A and Veeck G (2000) Consumer segmentation and changing food purchase patterns in Nanjing, PRC. World Development, 28(3): 457–471	3

The publications identified by the RPYS analysis give further insight into some of the paradigm shifts that have occurred in the urban food security field. In particular, according to Maxwell, (1996), three main shifts have occurred with food security thinking since the World Food Conference, 1974. There has been a shift from the national to household and individual level, from a food perspective to a livelihood perspective, and lastly from objective to subjective indicators. Based on a post-modern framework the author suggests that food policies should avoid over-arching narratives, but rather encourage innovation, and be task oriented (Maxwell, 1996).

Later publications in the year 2000 demonstrate these shifts by discussing food retail modernization, urban planning and consumer behavior in rapidly urbanizing areas. As an example, Goldman (2000) and Veeck and Veeck (2000) analyzed China's rapid socio-economic development and how that development supported the spread of supermarkets and exhibited cultural differences in consumer behavior compared to Westernized models. Godlman's (2000) consumer research results indicated food retail modernization process in Shanghai is driven by local supermarket chains and not international retail companies as seen in other countries. Godman's observation supports the phenomenon of 'selective' adoption where consumers in least developed countries purchase fresh food in traditional markets despite regularly patronizing supermarkets (Goldman, 2000). Goldman (200) explains that local supermarkets e.g., wet markets offer more variety in fresh vegetable and meat produce where customers can bargain on size and price of produce unlike in international supermarkets with prepackaged items.

Veeck and Veeck's (2000) research indicated that shopping habits were influenced by a person's gender and income and prompted further clustering into convenience

shoppers, frequent shoppers and traditional shoppers. Whilst convenience shoppers were more male dominated, with higher incomes, traditional shoppers were more female dominated and had lower incomes. Majority of respondents belonged to the cluster of traditional shoppers (Veeck & Veeck, 2000). Furthermore, distance of supermarket from residence and limited ownership of motor vehicles impacted the patronage of large supermarkets (Goldman, 2000). Future trends of food retail modernization must incorporate hybrids of local and international supermarket chains to address the needs of both traditional shoppers and convenience shoppers.

The influence of access to transport and distance of residence from supermarkets cited by Goldman, (2000) underscore the role of urban planning in strengthening food systems in communities (Pothukuchi & Kaufman 2000). The food system has vital connections with community systems including contributing to the city's economy, health, waste and transportation systems. Despite these interconnections, urban food systems are excluded from urban design and physical planning, social planning, environmental planning and technology planning (Pothukuchi & Kaufman 2000). Reasons for this exclusion include the lack of funding for planning and private market driven food systems (Pothukuchi & Kaufman 2000). Failure to integrate urban planning and food systems undermines food security in communities for example creation of food deserts (Guthman 2008 and Short, 2008 in Table 1).

More recently Cohen & Garrett (2010), the most cited paper identified in this investigation's corpus, also suggest that food policies must shift from rural-biased food production focus to align with urbanization trends. This shift is premised on the observation of high levels of food insecurity and informality in urban areas and broader vulnerability to food price hikes which can catalyze rioting and weaker social support for recent migrants especially women (Cohen & Garrett, 2010). The authors in Table 4 reverted to the underlying theme of UA as a solution to urban food insecurity backed by the inclusion of safety nets for the poor and investments in human capital and institutions as seen from most cited publications in Table 1 (Ellis & Sumberg, 1998; Zezza & Tasciotti 2010).

Similarly, other authors attempt to provide evidence in support of UA. Lee-Smith, (2010) quantifies the extent of UA in African cities by looking at the proportion of households engaging in UA and assessing the connections to urban food security and poverty. Even though UA is on the increase in African cities and contributes to food security and human health, such benefits do not apply to poor households particularly those headed by women because of limited access to land. This paper also concludes on the failure of UA in addressing urban food insecurity and poverty alleviation in the Global South as arrived at by others from Table 1 and 2.

The connection of themes in publications identified using RPYS indicate shifts in urban food policy approaches (Maxwell, 1996), modernization of food retail (Goldman, 2000; Veeck & Veeck 2000), the impact of urban planning on food systems (Pothukuchi & Kaufman, 2000) and finally contributions of urban agriculture to urban food security (Cohen & Garrett 2010; Lee-Smith, 2010). Overall, these papers show the importance of integrating better policies, context, urbanization trends, urban planning, consumer behavior and gender equality into future urban food security research. There is a general overlap with themes presented in Table 1 and 2 above.

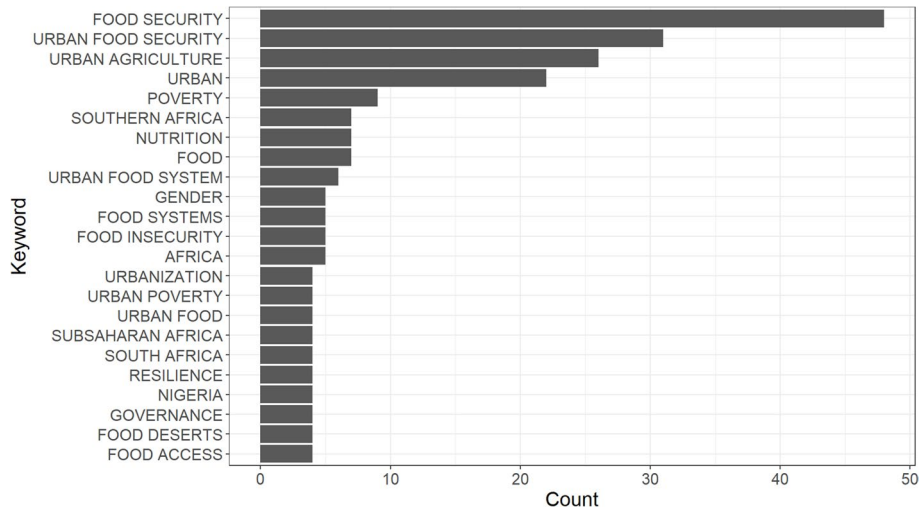

Fig. 5 Author keyword indexed terms

Content analysis

To evaluate how the conceptual building blocks of the field have evolved over time, we began with a simple keyword analysis, based on the author's select keywords (Fig. 5). This figure indicates the frequency with which various keywords were used by authors in the collected literature. Excluding words from the query (such as iterations of urban, food, and security), we identify some common themes. Most obvious is the focus on agriculture—in the context of nutrition, food systems, food deserts, and food access. Other notable topics relate to poverty, gender, and climate change. Finally, there is a distinctly African focus in the sample, with a regional focus on South Africa and Nigeria.

Finally, we examine combinations of words for our keyword analysis (Fig. 6). At times, this gives us greater context as to how a word may be used. Households for example, are often preceded by "poor" or followed by "income". Common solutions include rooftop

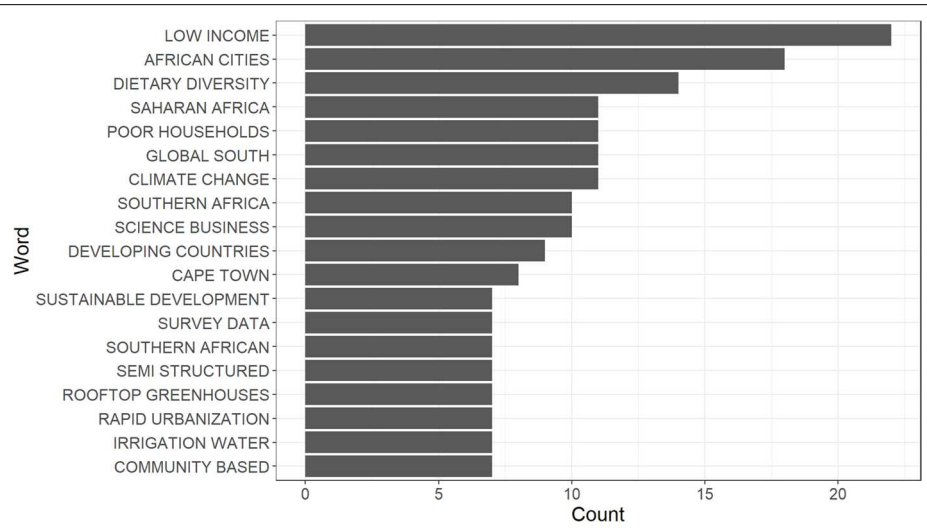

Fig. 6 Top combinations of words in abstracts

greenhouses and irrigation water. Combinations of three words allude to female headed households, crop production intensity, and the sustainable development goals.

A keyword co-occurrence network of the entire sample (Fig. 7) maps the top 80 keywords based on the relative frequency they occur in a document and clusters words using a multiple correspondence analysis (MCA) to draw underlying structures of common concepts. The MCA identifies several prevalent clusters of common concepts—1 on food security related to food supply, production, malnutrition, and obesity; 2 on agriculture in relation to policy, management, and food systems; and 3 on poverty in the context of urbanization, vulnerability, and gender. These co-occurrences align with the similar research themes identified in the RPYS analysis, validating the emergence of these clusters as research foci in the emerging field of urban food security.

Through this analysis, we have identified key topics of interest and the context in which they are used. However, we currently hold all topics on equal footing when that may not be the case. Thus, we turn to strategic diagrams (Cobo et al., 2011), which parses key words based on their relative importance to the topic. Thematic trends are categorized based on their word centrality (how important a word is to the research field) and word density (how developed the word is in the research field). We also divide the strategic diagrams over time, to examine the evolution of the field over time.

In Fig. 8a is the strategic diagram for publications prior to 2014. In the upper left quadrant are highly developed but isolated themes. Here, for example, we find specialized literature on consumption. In the bottom-left quadrent are weakly developed and marginal themes, such as topics around health and cities. Notably, clusters may also include other keywords – for example, other words in the "city" cluster include politics, government, systems, and security. In this strategic diagram (spanning until 2014), these words are among the least important to the field of research. To the bottom right are basic and transversal themes, which are important to the development of the research field but are not sufficiently developed. Notably, topics of food security in relation to nutrition and income are found here. This quadrant alludes to opportunity for future research as highly relevant to the body of literature, but could still be further developed as the nascent field matures. Finally, to the top right are motor clusters, which are both well developed and important to the field of research. We find here that themes related

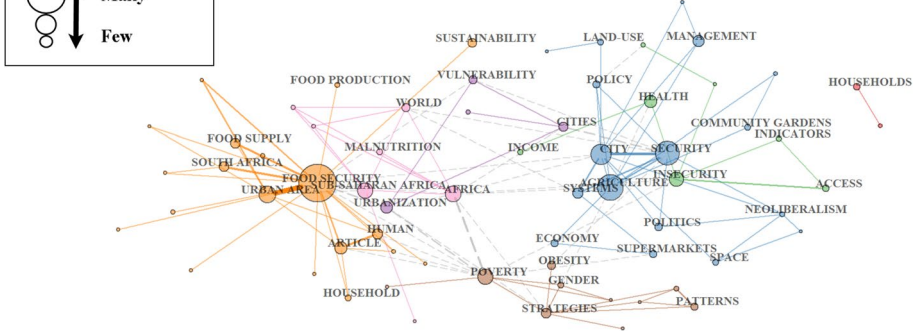

Fig. 7 Keyword co-occurrences

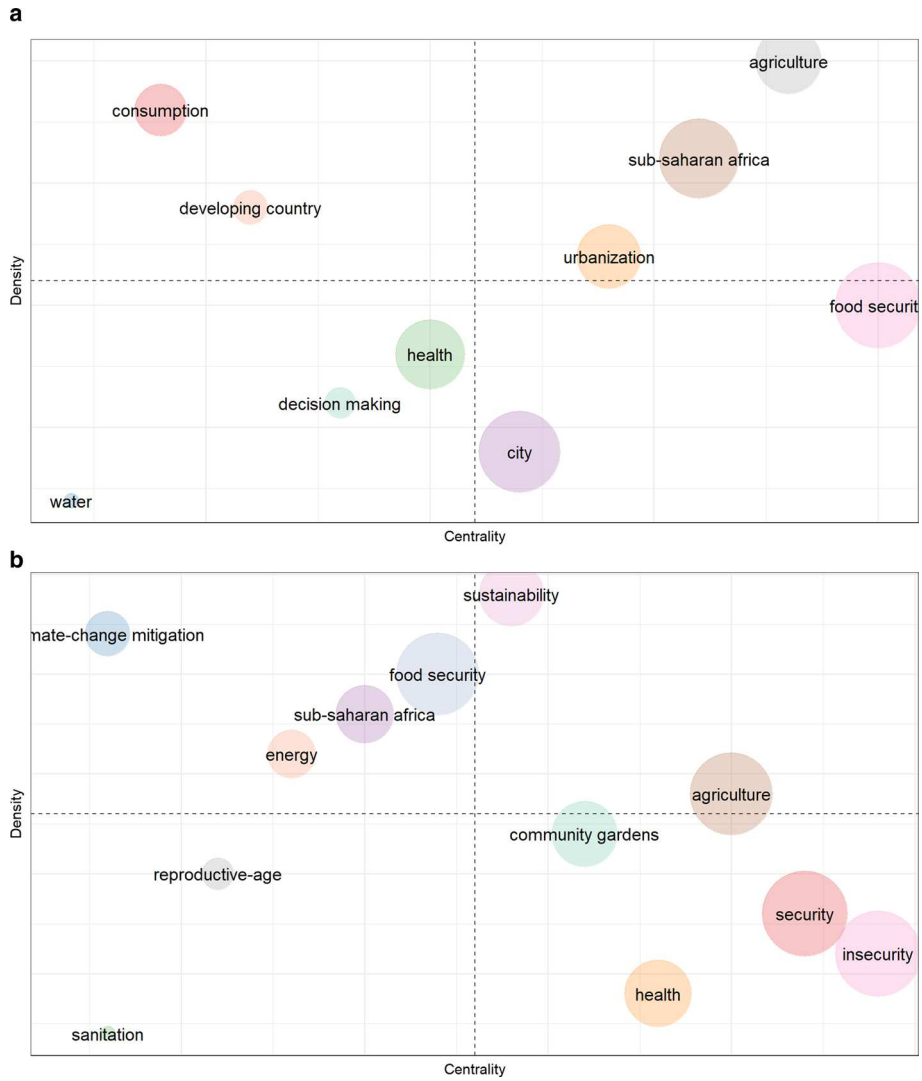

Fig. 8 a Strategic diagram 1988 – 2014. b Strategic diagram 2015 – 2019

to agriculture, food supply, urban areas, and poverty are highly specialized and foundational to the literature on urban food security.

In recent years however, there has been a substantial evolution in the importance of select topics. Figure 8b presents the strategic diagram for publications from 2014 to 2019. Topics related to food security (such as food availability, food safety, and urbanization) has developed considerably since 2015. The topic of agriculture (in relation to access and management) has in contrast, fallen in density. Discourse on Sub-saharan Africa has also become less important in recent years. New clusters like community gardens have arose, attesting to a potential shift in discourse from developing countries to developed countries. Finally, discourse around sustainability has proved to be both highly developed and increasingly important to the field of urban food security.

Comparing these two strategic diagrams indicates how themes with the urban food security literature (as demonstrated by publication key words) have evolved. As an

example, we note that the theme of agriculture has become less frequent in the literature (though linked to a diversity of other themes), while sustainability has become a frequent and cross-cutting theme in the collected journal articles. At the same time, the theme of health has emerged recently as a theme in the literature and time will tell whether this theme will become more frequent or integrated with other themes in the urban food security literature.

Conclusion

The analyses provided by this paper document the rapid growth of urban food security literature in recent years. While there has been recent work on food access in cities, the majority of the literature still focused on food supply (via investigations into urban agriculture and topical shift towards community gardening). More recently, however, urban food security has become increasingly aligned with a sustainability paradigm rather than an agricultural paradigm. This shift may recognize a growing alignment between SDG2 (zero hunger) and SDG11 (sustainable cities) in the Sustainable Development Goal framework. More specifically, the urban food security field has evolved to strengthen the link between green infrastructure and food security as sustainability initiatives in cities (Guthman, 2008). In other words, urban food systems have become increasingly analyzed through a sustainability lens (linking urban food security to broader discussions of sustainable urban development). The analyses carried out in this paper have also identified the potential emergence of key research clusters around urban food supply and health, poverty, and vulnerability.

Discussion

As a body of literature, the urban food security field has been premised as a response to the limited historical focus on food security in cities. Since its early work, the field has catalyzed an emerging recognition of the role that informality, food system transformations, food prices, and urban planning can play in defining urban food security. At the same time, we are witnessing a pivot in the field toward the assessment of urban food security from a sustainable development perspective. This pivot has opened the field to new policy options, beyond agricultural production, to support household food security in cities via urban design and governance.

While the field of urban food security is still very much an emerging one, the future of urban food security research looks promising (given the rising frequency and prominence of urban food security publications, along with the noted international author collaborations). At the same time, the field appears to be in a state of flux, with competing themes emerging and previously established themes declining in their frequency of use and dominance within the field. This discussion is also framed by a growing understanding of the importance of cities as catalysts for sustainable development. Within this context, the urban food security field has the potential to become a platform for conceptualizing the urban food system within the broader sustainable urban development literature.

This evolution within the field of urban food security has the potential to support more wholistic policies in support of food secure cities. By premising food security from an "access" perspective within broader food security discourse, future urban food security research may become instrumental in informing policies that are multi-dimensional

(intervening in the various root causes of food access challenges) and integrative (enhancing social, environmental, and economic outcomes). As a result, the evolution observed within the urban food security field has the potential to both open new avenues for investigation while supporting more wholistic and integrative food policies within cities.

Abbreviations

FAO: Food and Agriculture Organization; HFIAS: Household Food Insecurity Access Scale; LDCs: Less Developed Countries; MCA: Multiple Correspondence Analysis; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses'; PUA: Peri-urban Area; RPYS: Reference Publication Year Spectroscopy; SDG: Sustainable Development Goal; SME: Small-to-Medium Enterprise; UA: Urban Area.

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Authors' contributions

Bruce Frayne (supervision, funding, design, editing), Truzaar Dordi (analysis, writing), Cameron McCordic (supervision, writing, editing), Naomi Sunu (analysis, writing), Clare Williamson (analysis, writing). All authors have read and approved the final manuscript.

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Availability of data and materials

Data and R scripts for the analyses carried out in this investigation are available in the supplementary materials.

Declarations

Competing interests

The authors of this manuscript declare that they have no financial or non-financial competing interests related to the research carried out in this manuscript.

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