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Research Article

A Bibliometric Assessment of Urban Agriculture Indexed in Scopus and Wos From 1978-2023

[1]Emrobowansan Monday Idamokoro, [1]Augustine Suh Niba and [2]Eunice Amaka Akuru

[1]Department of Biological & Environmental Sciences, Faculty of Natural Sciences, Walter Sisulu University, Nelson Mandela Drive Campus, Mthatha, South Africa
[2]Department of Animal Science, Faculty of Natural and Agricultural Sciences, University of Pretoria, University of Pretoria, Hatfield, South Africa

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Corresponding Author:
Emrobowansan Monday Idamokoro
Department of Biological & Environmental Sciences, Faculty of Natural Sciences, Walter Sisulu University, Nelson Mandela Drive Campus, Mthatha, South Africa
Email: mondayidamokoro@gmail.com

Abstract: Urban agriculture is a system of food production in and around urban settlements aimed at ameliorating the challenge of food shortage. The goal of this study is to explore emergent worldwide publication trends, contemporary focus and gaps in urban agriculture research over the last four decades (1978-2023). Despite the numerous research work on urban agriculture, gap existed in literatures on a research to qualitatively quantify the collective global outputs of studies done on urban agriculture. A Bibliometric approach was employed to analyse the research publications extracted from the combination of WoS and Scopus data banks. A total of 3817 articles were recovered from these two databanks with an average citations per doc and co-authors per document ratio of 18.34 and 3.29, respectively. Studies on urban agriculture researches were positively correlated with the number of years (R^2 = 0.6507; y = 7.5651x - 95.562) suggesting a rise in the number of publications on the subject matter. The USA was ranked in the top position in terms of outputs and citation numbers (n = 605; 15612), followed by China (n = 284; 4648) and Germany (n = 181; 4786). The study indicated that urban agriculture is increasingly attracting global attention with an impressive rise in research publications from 2002 to 2023. The investigation on urban agriculture is mostly carried out in financially stable economies with minimal representations from developing nations and institutions. Some main emphasis and hotspot within the field of urban agriculture research is tailored towards food security, urban farming, urban gardening, sustainability, community gardening and climate change with minimal work on research in the aspects of policy and governance, thus signifying the direction for future investigations.

Keywords: Bibliometric, Research Trends, Urban Farming, Global Analysis, Sustainability

Introduction

The world's population keeps growing daily, and at present, more than 4.2 billion people live in metropolitan areas and urban settlements. The rate of urban population growth is projected to rise by an additional 2 billion by 2041. The recent sparks of natural disasters, diseases (e.g. recent Covid-19 crises), unpredictable rainfall and weather conditions and climate change, among others, have added to the increase in food prices globally (Godde *et al.*, 2021; Paudel *et al.*, 2023). The agricultural sector faces the huge challenge of safeguarding food security to meet the needs of the growing global human population, particularly in urban settlements, especially since these settlements are often confronted with the problem of food and nutrition safety (F.A.O., 2015). It was said that there are direct and indirect health effects arising from a lack of access to fresh food crops, including vegetables and fruits (Yusuf *et al.*, 2022). According to a study done in the US by the Food Research and Action Center, it was found that lack of quality access to fresh food (fruits and vegetables) by low-income earners led to the health condition of obesity/over-weight in about 30% of the population people (Yusuf *et al.*, 2022).

In a report by the UN (2011), it was predicted that the rise in human population will require more than a 60% rise in world food production. Agriculture currently provides about 98% of the global food resource, but with the astronomical rise in human population, the agricultural sector may encounter a massive

strain/challenge in meeting global food availability and nutrition security of people, especially for those living in the urban settlements (Çakmakçı *et al.*, 2023). Meanwhile, urban agriculture can contribute to global food availability and ensure sustainability and security (Pradhan *et al.*, 2024). On a global world assessment, urban agriculture is capable of generating an estimated 180 million tons of food annually, perhaps 10% of the world's food output (i.e. vegetables, roots and tubers, and legumes), if properly implemented in cities globally (Yusuf *et al.*, 2022).

Urban agriculture is the art and culture of planting and producing non-foodstuffs (such as medicinal herbs) and food crops (including mushrooms, vegetables and fruits) alongside livestock-based ventures such as aquaculture in and around cities (Duvernoy *et al.*, 2018). In the context of the present study, urban agriculture is also referred to as urban gardening or urban farming, which involves the cultivation, processing, and distribution of agricultural produce in or near major towns and cities. According to Wagstaff and Wortman (2015), urban agriculture refers to all kinds of agricultural production within or near a metropolis.

The multi-faceted functions and roles of urban agriculture have been well documented. These include the ability to supply fresh food crops (Altieri *et al.*, 1999), ensure social and environmental sustainability (Nicholls *et al.*, 2020), supply short-term food chain (De Zeeuw & Drechsel, 2015), provide urban diet and urban greening (Lovell, 2010) and supply effective waste management services (Bon *et al.*, 2010), amongst others. In addition, urban agriculture plays an essential role in plummeting the rate of urban poverty in most developing countries (Mkwambisi *et al.*, 2011; Siegner *et al.*, 2018). For instance, the practice of urban agriculture in India is recognized to be an economic tool capable of reducing multi-dimensional poverty (Marshall & Randhawa, 2017). It has also been reported that urban agriculture possesses the prospect of providing enough food, appropriate nutrition, and effective food-price supply within large cities where the craft is practised (Rezai *et al.*, 2016).

More importantly, urban agriculture plays a key role in the development of greener metropolises/towns and boosts urban climate (Dubbeling & Zeeuw, 2011). Several stakeholders and institutions are employing the techniques of urban agriculture to accomplish and meet several lofty objectives such as job creation, food availability and ecosystem support (Santo *et al.*, 2016). Although several authors (Idamokoro, 2023; Pradhan *et al.*, 2024) have reported on the adoption and practice of urban agriculture, there is a paucity of studies that have utilized bibliometric tools to report the research trends and related global topics on urban agriculture. Most scientists who worked on the current topic focused mainly on the effect of environmentally friendly crops, fruits, livestock or farm practices and how they are viable in urban settings (Duvernoy *et al.*, 2018; Yusuf *et al.*, 2022). Due to this fact, capturing the trends of topics and keywords that are frequently utilized by the authors has not been well documented.

Bibliometrics helps to determine the impact of research through the assessment of bibliometric outputs, for instance, the number of citations on a particular publication (Idamokoro & Hosu, 2022a). This approach can assist authors in evaluating the efficiency of their study as well as recognize areas that are most fascinating to other scientists in a bid to enable them to facilitate and come up with more innovative research that will be of interest to scholars globally (Ekundayo & Okoh, 2018). At the moment, it is unclear how many studies, as well as cited research work, have been done on urban agriculture in the previous years. Furthermore, the global statistics and evaluation of the widely used authors' keywords, research titles, and abstracts on this subject matter have not been well studied (Mohadab *et al.*, 2020).

In line with the aforementioned research gaps, the objectives of the current study are to determine the trend of scholarly research that is associated with urban agriculture based on the previous research that was indexed in Web of Science (WoS) and Scopus. The following research questions were formulated accordingly:

1. What are the key terminologies often employed by authors within the title and brief abstracts, as well as authors' research keywords related to urban agriculture and livelihood improvement?
2. How is the progress of intellectual citations on previous research work discussed within the subject matter (urban agriculture), and which nations and institutional affiliations ranked highest in publication and citation numbers?
3. How is the development of the regularly utilized keywords and other field distribution trends related to urban agriculture with regards to food production?

Conversely, it is important to note that bibliometric assessment is a research approach that uses mathematical metrics, as well as statistical methods, to describe and explain authors' research carried out on a particular subject niche (Aria & Cuccurullo, 2017). Like other bibliometric publications, we hope to present the knowledge pool that can give future directions on informative research and, in the long run, give a bigger picture to institutions, stakeholders and policymakers on future inclinations towards urban agriculture.

Materials and Methods

Data Management and Analysis

The present study utilized two databases (WoS and Scopus) to retrieve articles on urban agriculture. These

two data banks are well-known archives generally used for bibliometric-based studies because they have a broad spectrum of data capture as well as search queries for bibliometric research (Qin *et al.*, 2020; Zhang *et al.*, 2023). The aforementioned data banks were from WoS and Scopus. These two data archives are globally accepted because they are a reliable source for credible publications (Repiso *et al.*, 2018). In the present study, the title search was employed to gather data from Scopus and WoS for the purpose of a broader assemblage of documents required for the study from 1978 to 2023. Data obtained were later cleaned up and filtered (to remove articles that do not speak to the subject matter) before they were validated for evaluation. The process of data cleaning was achieved by carrying out a literature search in order to get appropriate author keywords that align with the intended subject matter. Our data collection technique has previously been employed by Fesseha *et al.* (2020). All retrieved and cleaned documents were further transferred into R Studio to remove all duplicated articles obtained from the combination of WoS and Scopus data collections. A pictorial illustration of the data collection, inclusion and exclusion is further explained in Fig. (1).

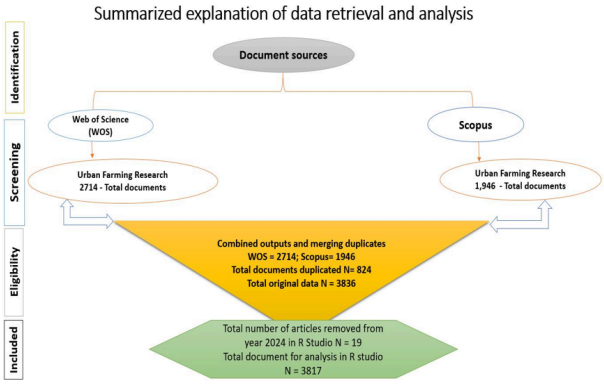

Fig. 1: Summary of the diagram on inclusion and exclusion of articles for bibliometric analysis

Data Processing

Data collected from the combined database of WoS and Scopus were analyzed via the bibliophily function before being assessed for their descriptive features in the bibliometric R-Studio packages. The descriptive results included global article spread per year, citation numbers by various authors and nations, literature source and their global impact, and trends of associated topics and subject matter (Aria & Cuccurullo, 2017). The R Studio software package was also used to present, tabulate and describe other bibliometric features such as the author's keywords/contributions, article keywords/keywords plus the author's global influence, organizations and frequency of citations, among others. The global impact of authors' contributions within a specific research field is determined by Lotka's law within the bibliometrix Software package (Lotka, 1926).

Results and Discussion

Summary of Research Information on Urban Agriculture

The results of the main information of all articles retrieved from WoS and Scopus are presented in Table (1).

Table 1: Summary of articles retrieved on urban agriculture research from WoS and Scopus database

Description	Results
Main information about the data	
Timespan	1978:2023
Sources (Journals, Books, etc)	1623
Documents	3817
Annual Growth Rate %	8.04
Document Average Age	7.22
Average citations per doc	18.34
References	101825
Document contents	
Keywords Plus (ID)	6328
Author's Keywords (DE)	7993
Authors	
Authors	8981
Authors of single-authored docs	672
Authors' collaboration	
Single-authored docs	828
Co-Authors per Doc	3.29
International co-authorships %	19.62
Document types	
Article	2951
Article book chapter	448
Article review	89
Proceedings Paper	274
Book chapter short survey	10
Editorial	16
Note	15
Others	14

The total number of documents that fall within the subject matter between 1978 and 2023 was 3817 and are available in 1623 data sources from 6328 research authors. The single-authored works on literature were written by 672 authors, whereas the co-authors per document on urban agriculture research had a percentage of 3.29 authors, respectively. For all the research publications included in the study, there was a sum of 101825 references with a document average age of 7.22. Furthermore, the average number of citations per document in urban agriculture was 18.34. The result of the author keywords (DE) and keyword plus (ID) was 7993 and 6328, respectively. All this aforementioned information (Table 1) gives a bibliometric breakdown of the literature summary of a research niche as commonly reported in other related bibliometric fields (Ekundayo & Okoh, 2018; Idamokoro & Niba, 2024).

Yearly Growth of Articles and Citations on Urban Agriculture Research

One of the advantages of bibliometric study is its use as a tool to define the growth of a scholarly subject matter over the years in terms of the yearly publication of articles within that research niche (Idamokoro, 2023). For instance, an annual decline in the number of publications in a niche area shows a decreasing interest by scholars on that subject matter (Okaiyeto & Oguntibeju, 2021). With respect to urban agriculture research, not many publications were recorded in the early years (1978–1992), as seen in Figure (2).

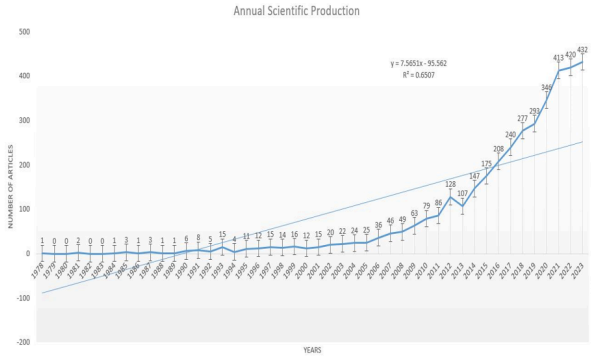

Fig. 2: The yearly number of articles on urban agriculture research from 1978 to 2023

Meanwhile, since 2002, there has been a substantial increase in the subject matter to date, with the highest number of articles published in 2023, amounting to 432 research outputs. Figure (2) Furthermore, research performance in urban agriculture recorded an annual rise of 8.04 %. Our findings were lower when compared to those reported in other bibliometric studies (Orimoloye & Ololade, 2021; Idamokoro & Hosu, 2022a; Idamokoro & Hosu, 2022b). Conversely, the rise in research publications on urban agriculture from the year 2001 is an indication that there is a growing global interest in the significance of the subject matter, particularly in agricultural sustainability and food security. This may be because, besides the economic impact of producing food in society, urban agriculture/farming is known to improve social and environmental (air and water quality enhancement, pollination and biocontrol activities) functions (Azunre *et al.*, 2019). In line with our findings, a related study on 'urban community garden systems' also reported an increase in the total number of publications in recent years (Zheng *et al.*, 2023). More recent publications on this subject matter require more time to gain adequate exposure and citations. Due to the vital role that urban agriculture plays in reducing urban poverty in most nations, especially in developing countries (Mkwambisi *et al.*, 2011; Siegner *et al.*, 2018) and in serving as an economic tool capable of plummeting multi-dimensional poverty (Marshall & Randhawa, 2017), the need to further increase research on the topic, cannot be overemphasized. According to Yusuf *et al.* (2022), the increase in publications in urban farming/agriculture research could be due to the frequent incidence of situational problems and challenges of the global community and how they relate to food security and safety.

Global Rated Researchers With Influence in Urban Agriculture Research

Our results showed that 8981 authors participated in the publication of 3817 articles from 1987 to 2023. Furthermore, co-authors per publication were 3.29, while the percentage of international co-authorship was 19.62, thus indicating the strength of collaboration and partnership by various global researchers in the studied research niche. Table (2) shows the 25 most influential authors in this research field, with a h-index of between 7 to 17 and article citations ranging from 92 to 2165. The observed number of citations seen in the present study was anticipated because of the high number of authors who reported their investigations on urban agriculture as compared to other bibliometric results who had a lower number of citations as a result of fewer authors in another study (Tywabi-Ngeva *et al.*, 2022; Yusuf *et al.*, 2022). The h-index rating is a metric that is often used to determine the influence of an author's work and how relevant the author is in a given research field (Huang *et al.*, 2019). In addition, the h-index rating is employed to appraise the significance of a work (via article citation numbers) and how prolific authors are within an organization globally or locally (Hirsch, 2005). The global score of authors, nations, organizations, and journal sources is often determined from their h-index rating, which usually aligns with the number of scholarly articles with regard to the citation numbers of other authors. H_index score is calculated by employing the logic that h research publications were cited for h number of times over a while (Hirsch, 2005). Furthermore, the h-index is an essential instrument used in evaluating an article/author's performance, as it gives accurate replicates of the scholarly impact on the pool of knowledge by an individual author/article (Guilak and Jacobs, 2011).

Of recent, several authors have argued that a mere count of article numbers does not give the exact impact of an author in a particular field because each authored manuscript gets a rating for each article but does not take into account the number of co-authors that are involved in writing the said paper (Altarturi *et al.*, 2023). A more appropriate benchmark has been suggested for scoring an author (or co-authors), which is by adopting a fractionalized metric for scoring their articles. This is done by dividing the score/rating of an article among the co-authors that contributed to the papers if it is not a sole or single-author paper (Altarturi *et al.*, 2023). This system of author impact and metric gives each author, or co-author, of a specific paper a score of 1 divided by the number of contributing authors to the manuscript. This

kind of evaluation metric has been utilized by several research organizations as well as journal sources such as the Nature Journal (Nature, 2018).

Table 2: Top 25 relevant authors on urban agriculture research

S/N	Element	h_index	g_index	m_index	TC	NP	PY_start
1	Gaston K	17	19	0.773	2165	19	2003
2	Egerer M	13	22	1.625	496	23	2017
3	Philpott S	13	19	1.3	812	19	2015
4	Warren P	13	13	0.591	1773	13	2003
5	Buerkert A	12	18	0.706	480	18	2008
6	Mcclintock N	12	15	0.8	1289	15	2010
7	Specht K	12	18	1.091	964	18	2014
8	Drechsel P	11	16	0.478	674	16	2002
9	Li Y	11	16	1	410	16	2014
10	Lin B	11	18	1.1	707	18	2015
11	Smith R	10	13	0.455	1095	13	2003
12	Thompson K	10	10	0.455	1212	10	2003
13	Aubry C	9	18	0.529	558	18	2008
14	Drescher A	9	12	0.429	266	12	2004
15	Orsini F	9	16	0.75	955	16	2013
16	Zhang L	9	12	0.75	213	12	2013
17	Binns T	8	11	0.296	354	11	1998
18	Cohen N	8	13	0.615	433	13	2012
19	Gianquinto G	8	10	0.667	932	10	2013
20	Chen Y	7	9	0.636	92	11	2014
21	Frey D	7	7	1	282	7	2018
22	Hardman M	7	11	0.636	199	11	2014
23	Li X	7	8	0.538	313	8	2012
24	Liu Y	7	13	0.583	365	13	2013
25	Moretti M	7	7	1	282	7	2018

Table (2) shows how the 25 most influential authors performed, from which researchers such as Gaston, Egerer, Philpott, Buerkert and Warren all contributed 19, 23, 19, 18 and 13 articles from the total sum of 3817 documents obtained from WoS and Scopus, respectively. In addition, these authors had an h-index of 17, 13, 13 and 15, accordingly. Conversely, the researcher named Mcclintock, N (h-index = 12) in the ^{sixth} position had a higher citation (n = 1289) when compared to the second, third and fifth-ranked researchers in the field. This points to the fact that the use of article citations is not only impacted by the publication numbers of an author and the rating of the h-index but also by the year of publication of the article (Okaiyeto & Oguntibeju, 2021). In line with our observation, notable authors in the field of urban agriculture, such as Mcclintock, N (h-index = 12), Aubry, C (h-index = 9) and Binns, T (h-index = 8), have been reported among the most influential authors in this niche area (Yusuf *et al.*, 2022).

Global Influential Organizations on Urban Agriculture Research

The information for the top twenty-five (25) organizations with the highest number of research publications in urban agriculture are presented in Table (3).

Table 3: The 25 topmost globally relevant research organizations on urban agriculture with over 30 publications

S/N	Affiliation	Nation	Articles	Ranking
1	Cornell University	USA	56	1st
2	Kassel University	Germany	56	1st
3	Arizona State University	USA	55	2nd
4	National University Singapore	Singapore	53	3rd
5	Swedish University Agricultural Science	Sweden	52	4th
6	University Autonoma de Barcelona	Spain	51	5th
7	University California Santa Cruz	USA	50	6th
8	Tokyo University	Japan	49	7th
9	Ohio State University	USA	47	8th
10	Michigan State University	USA	44	9th
11	Copenhagen University	Denmark	40	10th
12	Illinois University	USA	40	10th
13	Sao Paulo University	Brazil	40	10th
14	Institute Geography Science and Natural Resources Research	China	38	11th
15	Paris Saclay University	France	38	11th
16	University Autonoma Barcelona	Spain	37	12th
17	California Berkeley University	USA	36	13th
18	Wake Forest School of Medicine	USA	36	13th
19	Zhejiang University	China	36	13th
20	California Davis University	USA	34	14th
21	Ghent University	Belgium	33	15th
22	Nanjing University	China	32	16th
23	Padjadjaran University	Indonesia	31	17th
24	Sheffield University	England	31	17th
25	Wageningen University and Research	Netherlands	31	17th

Cornell University from the USA and the University of Kassel from Germany both published the highest amount (n = 56) of articles on urban agriculture globally, while Arizona State University from the USA had the second highest number (n = 55) of articles. Meanwhile, Wageningen University and Research from the Netherlands was ranked the 25th institution (n = 31) on the list of global organizations that have published on urban agriculture (Table 3). Furthermore, 36% (9 out of the 25) of the topmost global organizations are from the USA (Table 3). This finding is in line with previous bibliometric studies that also reported institutions from the USA as top-ranked organizations from a widespread different body of knowledge (Chriki *et al.*, 2020; Idamokoro & Hosu, 2022b; Idamokoro & Niba, 2024). In line with our discovery, Yusuf *et al.* (2022) reported that the University of Tokyo (Japan) and the University of Ghent (Belgium) were among the top-rated institutions conducting research on urban agriculture.

Most Influential Journal Source on Urban Agriculture Research

Different journal outlets suggest their research niche and area of specialty on different research topics (Idamokoro & Niba, 2024). The number of research

topics in a given journal is an essential benchmark in bibliometric analysis for propagating relevant scholarly information (Leydesdorff & Rafols, 2009). In the present study, the most relevant sources (journals) for articles on urban agriculture research were evaluated (Table 4).

Table 4: The 25 most relevant journal sources in urban agriculture research based on the numbers of articles and h_ index from 1978–2023

S/N	Element	h_index	g_index	m_index	TC	NP	PY
1	Landscape and Urban Planning	31	54	1.476	2922	54	2004
2	Land Use Policy	29	56	0.829	3362	85	1990
3	Science of the Total Environment	26	39	0.839	1577	50	1994
4	Sustainability	26	35	2.167	1773	125	2013
5	Urban Forestry \& Urban Greening	23	34	1.533	1300	51	2010
6	Journal of Cleaner Production	20	31	2.222	1100	31	2016
7	Agriculture and Human Values	17	33	0.654	1573	33	1999
8	Urban Ecosystems	16	28	1.231	841	43	2012
9	Geoforum	14	16	0.609	603	16	2002
10	Renewable Agriculture and Food Systems	14	24	0.667	798	24	2004
11	Environmental Pollution	13	16	0.591	971	16	2003
12	Sustainable Cities and Society	13	20	1.3	416	22	2015
13	Applied Geography	12	15	0.462	610	15	1999
14	Cities	12	19	0.48	391	19	2000
15	Journal of Rural Studies	12	18	0.353	971	18	1991
16	Land	12	17	1.333	404	50	2016
17	Local Environment	12	25	0.8	847	25	2010
18	Plos One	12	19	1.091	495	19	2014
19	Agronomy for Sustainable Development	11	14	0.733	1508	14	2010
20	Habitat International	10	14	0.333	406	14	1995
21	Urban Studies	10	14	0.37	427	14	1998
22	Development Southern Africa	9	13	0.281	289	13	1993
23	Frontiers in Sustainable Food Systems	9	15	1.286	289	34	2018
24	International Journal of Agricultural Sustainability	9	12	0.6	378	12	2010
25	International Journal of Environmental Research and Public Health	9	19	0.9	384	26	2015

TC Total Citation; NP Number of Publications; PY Publication Start Year

The results for the most influential journal sources included citation numbers and h-index of the different journal sources (Table 4). The first five ranked journals were Landscape and Urban Planning (h-index= 31; NP = 54), Land Use Policy (h-index = 28; NP = 85), Science of the Total Environment (h – index = 26; NP = 50), Sustainability (h-index = 26; NP = 125), Urban Forestry & Urban Greening (h - index = 23; NP = 51), respectively, which are journal sources that started publishing on urban agriculture between 1990 and 2013. These journal outlets are known sources for disseminating scholarly information that is related to urban agriculture research and other related studies. In accordance with our findings, Yusuf *et al.* (2022) and Zheng *et al.* (2023) also reported some of the aforementioned journal sources as the most influential outlets for urban agriculture research. Meanwhile, it was noted from our results that Sustainability had the highest Number of Publications (NP) but was placed in the fourth position due to its lower h-index when compared to the other top three journal sources. This shows that even though a journal source might have high publication numbers on a subject matter, if its h-index is low, its ranking in terms of the most impactful source will be lower compared to those with a higher h-index (Yusuf *et al.*, 2022). Some of the known reasons why the Journal of Sustainability is among the highest-ranked journals maybe because it is an access journal that covers large study areas, churns out rapid publications, has a good reputation, and has wider targeted scholarly societies, among other factors (Yusuf *et al.*, 2022).

Most Influential Globally Cited Articles in Urban Agriculture Research

The indices of citation for rating any research paper indicate the number of citations that the paper received from other scholarly authors within a given period of time (Okaiyeto & Oguntibeju, 2021). In addition, the global citation of research articles is reliant on the intellectual worth of the citing papers rather than how popular the paper is being cited in the academic sphere (Idamokoro, 2023). For instance, a scholarly document that is cited by a very impactful manuscript often attracts global attention from other researchers who are expertise in the field, whereas the number of times a paper is cited determines its global influence without taking into account the value of the manuscripts that are citing it (Okaiyeto and Oguntibeju, 2021).

The Total Citations (TC) and Total Citations per year (TC/Year) observed in Table 5 ranged from 225 to 524 and from 7.21 to 61.86. The global influence and impact of an article in the intellectual sphere are generally evaluated by citation numbers (Tahim *et al.*, 2016). This citation impact improves with years as the citation number grows (Faggion *et al.*, 2017). However, the rise in citation numbers of a publication may attract negative criticism due to the practice of self-citation by some authors (Cheek *et al.*, 2006). Conversely, although newly published articles may have fewer citations, their citations accumulate years after publication (Feijoo *et al.*, 2014).

The results of top-rated papers judged based on their citations per year (TC/Year), as well as the total citations (TCs) in urban agriculture research from 1978–2023, are

presented in Table (5). It was evident from the results that authors such as Zasada (2011), Orsini *et al.* (2013), Flörke *et al.* (2018), Zezza and Tasciotti (2010), and Mcclintock (2014) published the five globally most cited documents in urban agriculture, with each paper having over 400 citations. All these aforementioned documents were published in Land Use Policy (TC: 524; TC/Year: 37.43), Agronomy for Sustainable Development (TC: 457; TC/Year: 38.08), Nature Sustainability (TC: 433; TC/Year: 61.86), Food Policy (TC: 420; TC/Year: 28.00), and Local Environment (TC: 413; TC/Year: 37.55). Our study findings differ from what was reported in a related study by Yusuf *et al.* (2022), that the article by Zezza and Tasciotti (2010) had the highest citation numbers and, therefore, was placed in the fourth position, contrary to what we reported. The reason for the contrast may be due to the use of two different databases, i.e. WoS and Scopus, in our analysis, as against one database (Scopus) used by Yusuf *et al.* (2022).

Table 5: Top 24 most cited documents on urban agriculture research

S/N	Article	DOI	Total Citations	TC per Year	Normalized TC
1	Zasada, 2011, Land Use Policy	10.1016/j.landusepol.2011.01.008	524	37.43	16.70
2	Orsini *et al*., 2013, Agron Sustainable Dev	10.1007/s13593-013-0143-z	457	38.08	12.53
3	Flörke *et al*., 2018, Nat Sustain	10.1038/s41893-017-0006-8	433	61.86	19.38
4	Zezza and Tasciotti, 2010, Food Policy	10.1016/j.foodpol.2010.04.007	420	28.00	9.56
5	Mcclintock, 2014, Local Environ	10.1080/13549839.2012.752797	413	37.55	11.32
6	Barthel, 2010, Glob Environ Change-Human Policy Dimens	10.1016/j.gloenvcha.2010.01.001	364	24.27	8.28
7	Wakefield *et al*., 2007, Health Promot Int	10.1093/heapro/dam001	352	19.56	7.22
8	Alaimo, 2008, J Nutr Educ Behav	10.1016/j.jneb.2006.12.003	325	19.12	6.91
9	Mok, 2014, Agron Sustainable Dev	10.1007/s13593-013-0156-7	324	29.45	8.88
10	Specht *et al*., 2014, Agric Human Values	10.1007/s10460-013-9448-4	317	28.82	8.69
11	Matteson *et al*., 2008, Ann Entomol Soc Am	10.1603/0013-8746(2008)101[140:BRAAIN]2.0.CO;2	309	18.18	6.57
12	Mathieu *et al*., 2007, Landsc Urban Plan	10.1016/j.landurbplan.2006.11.009	284	15.78	5.83
13	Lal, 2020, Food Secur	10.1007/s12571-020-01058-3	279	55.80	22.23
14	Lin, 2015, Basic Appl Ecol	10.1016/j.baae.2015.01.005	278	27.80	9.80
15	Smith *et al*., 2006, Biol Conserv	10.1016/j.biocon.2005.10.045	277	14.58	6.03
16	Barthel, 2013, Ecol Econ	10.1016/j.ecolecon.2012.06.018	272	22.67	7.45
17	Bon *et al*., 2010, Agron Sustainable Dev	10.1051/agro:2008062	265	17.67	6.03
18	Loram *et al*., 2007, Landsc Ecol	10.1007/s10980-006-9051-9	257	14.28	5.27
19	Shamshiri *et al*., 2018, Int J Agric Biol Eng	10.25165/j.ijabe.20181101.3210	252	36.00	11.28
20	Mcclintock, 2014, Camb J Regions Econ Soc	10.1093/cores/rsq005	248	16.53	5.64
21	Smit and Nasr, 1992, Environ Urban	10.1177/095624789200400214	238	7.21	3.17
22	Tornaghi, 2014, Prog Hum Geogr	10.1177/0309132513512542	235	21.36	6.44
23	Mougeot LJA, 2005, Agropolis: The Soc, Political and Environ Dimensions of Urban Agric-A	10.4324/9781849775892	234	11.70	6.41
24	Schmelzkopf, 2002, Geogr Rev	10.2307/215279	225	7.50	4.91

Of interest is that the pressing topics covered in the aforementioned (top-ranked) articles addressed a range of research related to the importance of urban agriculture in ameliorating hunger and food insecurity, thereby ensuring food sustainability in urban settlements and their environs. For example, in the article written by Zasada (2011), it was reported that there is a reasonable quest among urban dwellers to allow multiple functions and values for farming in urban centres. The paper also reported how peri-urban/urban agriculture directly contributes to the quality of life (in terms of food availability and quality) of its dwellers. In the paper, the author stated that farmers have innovatively responded to the pressures associated with the availability of food after decades of adaptation to the geographical and landscape amenities, which commonly pose a challenge in these areas (Zasada, 2011). The work on urban farming/agriculture by Zasada (2011) must have warranted the reason why it has accrued so many citations by other researchers.

In another study from the second most cited article (Orsini *et al.*, 2013), it was reported that urban agriculture in several cities of developing nations has significantly contributed to the food and nutrition security of urban households. Again, the authors alluded to the fact that urban agriculture will gain more recognition shortly due to its benefits of meeting the demands for food, fruits and vegetables of the rapidly growing people in towns and cities, especially in developing countries (Orsini *et al.*, 2013). Due to the significance of urban agriculture, the sector is bringing together a category of stakeholders (health practitioners, political authorities and officers) who are hugely

involved in providing support to people dwelling in several communities to meet their nutritional needs through intervention-based initiatives (Orsini *et al.*, 2013).

The work by McClintock (2014), in another highly cited paper, is shown in our results (Table 5). According to the authors, several urban agriculture initiatives across the world are reclaiming food farming and markets by re-embedding the agri-food system with social relations and by advocating for equity, sufficiency, and ecological functionalities. This simply means that urban agriculture should be well-positioned, and beyond the mere provision of food for urban settlers, it should also assist in buffering food security, creating jobs, and providing ecosystem services and a green environment (McClintock, 2014). Furthermore, in the fourth-ranked highly cited study by Zezza and Tasciotti (2010), the authors reported empirical proof from a collection of samples from developing nations showing a positive statistical relationship between engagement in urban agriculture and nutrition availability among its growing populace. The study further expounded on the burning issues relating to urban agriculture, poverty, food security, and safety and how they can help improve livelihoods in developing nations.

Topmost Influential Countries Based on Publication and Citation Numbers on Urban Agriculture Research

The top 24 highly influential nations with more article and citation numbers on urban agriculture research are tabulated in Table (6).

Table 6: Topmost relevant countries on urban agriculture research based on article numbers and citations

Rating based on article numbers							Rating based on TC		
Ranking	Country	Articles	SCP	MCP	Frequency	MCP_ Ratio	TC	Ranking	AAC
1	USA	605	519	86	0.159	0.142	15612	1st	25.80
2	China	284	219	65	0.074	0.229	4648	4th	16.40
3	Germany	181	122	59	0.047	0.326	4786	3rd	26.40
4	United Kingdom	171	125	46	0.045	0.269	5964	2nd	34.90
5	Australia	121	92	29	0.032	0.24	2963	6th	24.50
6	France	119	86	33	0.031	0.277	2660	8th	22.40
7	Canada	115	99	16	0.03	0.139	3182	5th	27.70
8	Italy	108	91	17	0.028	0.157	2962	7th	27.40
9	Spain	108	76	32	0.028	0.296	2602	9th	24.10
10	Brazil	99	82	17	0.026	0.172	790	16th	8.00
11	South Africa	80	65	15	0.021	0.188	1248	13th	15.60
12	Japan	74	54	20	0.019	0.27	1121	14th	15.10
13	Netherlands	72	40	32	0.019	0.444	2092	10th	29.10
14	Indonesia	67	66	1	0.018	0.015	320	23rd	4.80
15	India	61	53	8	0.016	0.131	597	19th	9.80
16	Sweden	50	33	17	0.013	0.34	1825	11th	36.50
17	Malaysia	47	33	14	0.012	0.298	586	20th	12.50
18	Ghana	43	27	16	0.011	0.372	1006	15th	23.40
19	Poland	41	33	8	0.011	0.195	325	22nd	7.90
20	Switzerland	40	22	18	0.01	0.45	1297	12th	32.40
21	Ethiopia	39	28	11	0.01	0.282	234	24th	6.00
22	Belgium	35	16	19	0.009	0.543	522	21st	14.90
23	Portugal	35	23	12	0.009	0.343	697	17th	19.90
24	Singapore	31	22	9	0.008	0.29	640	18th	20.60

SCA Single Country Articles; MCA Multiple Country Articles; TC Total Citations; AAC Average Article Citations

From the results, eleven countries are from Europe (Germany, UK, France, Italy, Spain, Netherlands, Sweden, Poland, Switzerland, Belgium and Portugal), seven countries are from Asia (i.e. China, Australia, Japan, Indonesia, India, Malaysia, and Singapore), three countries from Africa (South Africa, Ghana and Ethiopia), two of the countries are from North America (i.e. USA and Canada) and one country is from South America (Brazil), accordingly. This result indicates that European nations were more intentional in their research on urban agriculture. The aforementioned contributions from the USA, China, Germany, and the UK depict them as influential nations in the urban agriculture research domain. In line with our findings, related studies on urban farming/agriculture, community garden systems also reported countries including USA, China, Germany, UK, Italy and South Africa as top nations conducting research on urban agriculture (Dobele & Zvirbule, 2020; Zheng *et al.*, 2023). Based on the World Bank report, our result showed that the majority of the studies on urban agriculture were from economically stable countries, followed by those from upper to middle-income class countries (World Bank, 2024). Relatively few studies on urban agriculture were carried out by lower to middle-

income class nations (Table 6). The top 9 nations in terms of article and citation numbers from our results are all from high-income nations. Meanwhile, Brazil (99 articles and 790 citations) and South Africa (80 articles and 1248 citations) are the conspicuous performers among the upper to middle-income nations, while Indonesia (67 articles and 320 citations) is the representative of the lower to middle-income nations.

As seen from our results and from other previous authors, researchers from economically stable nations have keenly published articles on urban agriculture when compared to authors from developing or under-developed nations. This may be due to factors such as general awareness of health, societal issues, and land availability, which differ between developed and developing nations (Yusuf *et al.*, 2022). Most people from economically stable nations bother themselves with issues related to unhealthy diets (i.e. lifestyle-societal-related issues), whereas people from developing/ underdeveloped nations bother themselves with environmental challenges such as disease, disabilities and death. These contrasting issues (from developed and developing nations) may have challenged researchers and academics from developing nations (who are more proactive) to keep embarking on research in urban agriculture that gives quality diets to its dwellers and does not need extensive land to execute (Yusuf *et al.*, 2022).

There were position switches and exchanges in the rankings among the top 24 most influential countries that were placed as the most active countries in urban agriculture when the outcomes were assessed based on Total Citation (TC) per country (Table 6). This observation is in accordance with the result of other bibliometric studies as reported by other authors (Orimoloye & Ololade, 2021; Idamokoro & Niba, 2024). The possible reason for the ranking switch in the ratings (for countries) when using the citation numbers to determine the author's outputs may describe its unpredictability as a reliable instrument to define the productivity of authors in bibliometric studies. According to Fricke *et al.* (2013), the frequency of article citations of a specific nation does not spontaneously depict the number of publications of an author or nation. This is because the lesser the number of articles used for evaluation in bibliometric analysis, the more significant a few regularly cited publications are (Fricke *et al.*, 2013). For example, some authors self-cite, while others give false citations when citing other researchers' works, resulting in pseudo-qualitative and quantitative metrics of citations of authors or countries (Ekundayo & Okoh, 2018).

Article Word Growth on Urban Agriculture Research from 1990 to 2022

The assessment of the most frequently used word growth is shown in Figure (3).

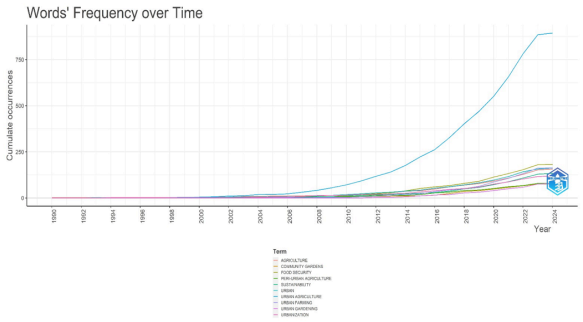

Fig. 3: Words' frequency growth of the 10 topmost keywords in urban agriculture research

From our observation, the result of world growth in urban agriculture started in a slow trend in the early years (from 1990–2024). However, this trend took a gradual rise from 2012–2023, making them earn accolades as the most frequently used words. The word "urban agriculture" showed a distinctive growth compared to other words such as community gardens, agriculture, food security, peri-urban agriculture, urban, and sustainability, among others, from 2012–2023. The word "food security" also showed a substantive yearly frequent word growth, as seen in Figure 3. Our observation was in line with the result of a previous study on 'urban food security research", in which it was reported that in recent years the subject matter has been affecting and changing the research priorities of institutions, governments and policymakers of several nations of the world (Frayne *et al.*, 2022). Our result on the rise in research publications on urban agriculture is not out of place, as previous studies also confirm this (Frayne *et al.*, 2022). The rise in publications on urban agriculture is gaining increased global attention because of the recent growing concern about food shortage in several communities, especially in large developed cities and in Africa (Smit, 2016). It is not surprising that research focused on improving food production and availability in the cities is being prioritized. Orsini *et al.* (2013) opined that an estimated 25–30% of urban dwellers globally are currently involved in the agro-food business. The importance of urban agriculture has finally attracted the attention of several local agencies, thus creating room for agriculture in the urban master plans of their cities in a bid to encourage smart urban agriculture (Prain, 2010).

Frequently Used Authors' Keywords and Word Cloud on Urban Agriculture Research

Authors' keywords are employed as academic metrics to project research subject matters and hot spots in various research fields (Synnestvedt *et al.*, 2005). Journal editors often require authors to list the keywords in the summary of their paper in order to know if they meet the scope of the journal before any further review process can be allowed on the paper. Authors' keywords are also vital to scholars who intend to acquire knowledge from a

manuscript because they assist them in recognizing the major aspects that are captured by the writer/s of a manuscript, and this practice is compulsorily included in the abstract segment of a manuscript (Okaiyeto & Oguntibeju, 2021).

Table 7: Top 25 most relevant words used by authors in urban agriculture research

S/N	Authors Keywords (DE)	Occurrences	Keywords Plus (ID)	Occurrences
1	Urban agriculture	876	Agriculture	402
2	Food security	180	Urban agriculture/s	240
3	Urban farming	161	City	239
4	Urban	158	Community gardens	172
5	Agriculture	156	Urbanization	171
6	Sustainability	132	Food	169
7	Urbanization	119	Health	162
8	Urban gardening	76	Food security	155
9	Community gardens	75	Management	151
10	Peri-urban agriculture	75	Cities	136
11	Urban planning	73	Ecosystem services	131
12	Biodiversity	52	Biodiversity	129
13	Ecosystem services	51	Sustainability	125
14	Food	46	Diversity	106
15	Urban gardens	46	Space	100
16	Climate change	44	Systems	98
17	Sustainable development	43	Land-use	97
18	Urbanization	41	Land	93
19	China	40	Sustainable development	88
20	Land use	40	Growth	87
21	Urban ecology	40	Conservation	86
22	Resilience	38	Impact	84
23	Farming	37	Politics	72
24	Community Garden	34	Food supply	71
25	Peri-urban	34	Vegetables	71

Fig. 4: Word cloud on urban agriculture research from 1978 to 2023

Table (7) and Figure (4) capture authors' keywords and keywords plus for research in urban agriculture from 1978 to 2023.

The most relevant keywords utilized by authors for urban agriculture research include Urban agriculture (n = 876), Food security (n = 180), Urban farming (n = 161), Urban (n = 158), Agriculture (n = 156), Sustainability (n = 132), Urbanization (n = 119), Urban gardening (n = 76), Community gardens (n = 75), Peri-urban agriculture (n = 75) and Urban planning (n = 73) among others. Conversely, it is important to note that most of the earlier-mentioned keywords from authors have occurrences of n > 30 (Table 7).

Worthy of note is the fact that the varied keyword groups and sizes in different colours, as depicted in the word cloud (i.e. Figure 4), signify how strongly related these keywords are to the subject matter and the related field in urban agriculture. Previous studies have also reported the significance of the sizes of keywords on the word cloud and how closely related they are with a studied subject field (Altarturi *et al.*, 2023). Meanwhile, our result compares favourably with previous findings on keywords for word cloud in relation to urban agriculture (Yusuf *et al.*, 2022). Essentially, keywords and keywords plus are used to address the themes of important subjects in a niche area, and these keywords also help would-be readers of a paper to pay attention and understand the vital concepts of the niche area (Chen *et al.*, 2014).

Treemap of Research Field Distribution in Urban Agriculture

From our analysis of the articles associated with urban agriculture to food production and security, we can deduce that urban agriculture is a means of reducing food insecurity in cities. It involves several niche directions, including food security, urban farming, agriculture, sustainability, urbanization, urban gardening, community gardens, peri-urban agriculture, urban planning, biodiversity, sustainable agriculture and land use, among others. The present study offers a direction for the improvement of research on urban agriculture, particularly when addressing food production in big cities (Figure 5).

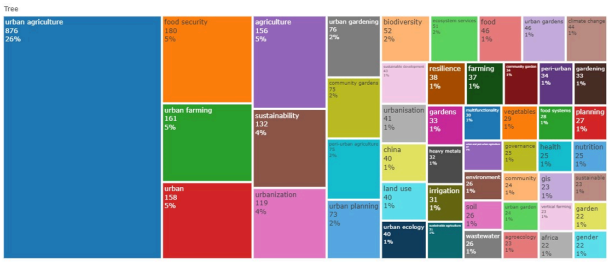

Fig. 5: Treemap of field distribution in urban agriculture research

One of the biggest challenges identified when conducting research on urban agriculture within large cities across the world is the issue of land accessibility (Opitz *et al.*, 2016). This underpins the need for policies on land use (Figure 5) to be critically looked into by policymakers and government officials when attempting to address the problem of food shortage within and around large cities. Some advanced and economically

stable nations address land use issues by researching alternative methods in food production and other farming approaches, such as rooftop horticulture and edible green facilities (Russo *et al.*, 2017).

Again, when addressing the challenges associated with urban agriculture, it should be noted that urbanization drives land-use changes in several large cities, more so with regard to the large amount of carbon dioxide gas emitted from automobiles into the communities. This situation has necessitated research on smart approaches to farming, such as rooftop vegetable gardens and edible green systems of farming, such as school gardens and home gardens, amongst other smart farming approaches that can potentially boost the production of fresh fruits and vegetables for urban dwellers (Frayne *et al.*, 2022). In the same vein, the current multi-benefits of urban agriculture will become essential for the sustainability of current and future city food production and supply and encourage several governments, policymakers, and institutions to adopt this type of farming system (Orsini *et al.*, 2013).

Limitations of Study Research Output

Despite the several benefits of the bibliometric analysis of the present investigation on urban agriculture, it is necessary to acknowledge the limitations that we encountered in the study. The published academic articles on urban agriculture research of the present study were evaluated using WoS and Scopus databases so as to allow numerous coverages of the targeted articles. However, it is possible that some articles published in other indexed scholarly databases (PubMed, Google Scholar, etc.) might have been omitted and not included in the documents used for our analysis. Therefore, the results of our study may not have holistically covered all the relevant articles that should be accessible on the topic of consideration that should be incorporated into the study.

Conclusion

The current study revealed a global bibliometric analysis of research on urban agriculture, with the majority of the relevant and influential organizations, nations and authors coming from financially stable and high-income economies. Furthermore, there was a rise in research investigations on urban agriculture from 2002 to 2023, giving credence to the fact that research in urban agriculture is gaining increased research focus and, by extension, worldwide attention. This may be due to the significant need for improvement in food production, security and sustainability of urban communities. Our result also revealed how influential and relevant top-rated researchers are in urban agriculture, with some of them having a high h-index of above 16 with very high citation numbers. It is pertinent for researchers from developing nations to engage in collaborative research with colleagues from developed nations since it is a more sustainable way of combating the growing challenge of food insecurity and sustainability in those regions.

Future Perspectives and Recommendations on Urban Agriculture Research

The need to improve and promote food production in order to meet the growing global human population cannot be over-emphasized. Urban agriculture is currently one of the many approaches that can be used to tackle global food shortages within and around big cities in most developed and developing nations. However, due to rapid urbanization and land use policies common with large cities, research on urban agriculture is still facing some obvious challenges. Future investigations on urban agriculture should, therefore, be focused towards finding better ways to understand the complex relationships between growing food crops (e.g. fruits, vegetables, other related farming items, etc.), city residents, the urban community, land use policies, with the intent to create the conditions for lasting upgradable structures that are able to adapt to community dynamics whilst taking into account the challenges of climate change in urban areas. More research on policy and governance in relation to urban agriculture is also of the essence in tackling the challenges faced in promoting farming in urban settlements. Furthermore, the availability of quality food produce, management of crop residues (including food waste and water conservation) and how they complement the various actors involved in the food production chain are other aspects that should be considered in research aimed at the future development of the sector. Again, another possible aspect of future consideration is in the area of effective training and technical support for all actors of urban agriculture, with a special focus on soil and water management, farm management, postharvest management, crop waste management and control of any possible risks with respect for both human health and the urban environment.

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Authors' Contribution

Emrobowansan Monday Idamokoro: Did data collection and analysis, wrote, edited, and reviewed the manuscript.

Augustine Suh Niba: Provided logistics and supervision, as well as manuscript review.

Eunice Amaka Akuru: Conceptualized the study, edited and reviewed the manuscript.

Ethics

This research is original and includes unpublished material. The authors conducted the study in accordance with the ethical principles and guidelines established by their field and institution.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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