

# Emerging Global Trends in Urban Agriculture Research: A Scientometric Analysis of Peer-reviewed Journals

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## ABSTRACT

Urban agriculture is the practice of production of food and non-food items in and around the urban area. This study aims to explore emerging global research trends, topical focus and gaps in peer-reviewed urban agriculture research for fifteen years (2004-2018). Bibliometric methods were used to analyse the research articles on urban agriculture extracted from SCOPUS database. The study shows that urban agriculture has been increasingly gaining attention in the research agenda with a sudden rise in research articles from 2013 onwards. The research on urban agriculture is largely centred in the Global North with minimal representation from institutions of the Global South. Major reasons for increased urban agriculture research in the Global North could be historical factors, grassroots community gardening initiatives and an increased demand for local food. Most of the research in urban agriculture is carried out in the subject area of Social Sciences. Main emphasis within urban agriculture research is given to food security, sustainability and community gardening. Keyword analysis indicates a recent shift in the research focus towards exploring socio-environmental sustainability potential of urban agriculture. Our findings show very little research in the areas of policy and governance related to urban agriculture.

**Keywords:** Urban agriculture, Scientometrics, Sustainability, VOSviewer, Research trend, Keyword analysis.

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Received: 27-02-2020

Revised: 12-07-2020

Accepted: 01-08-2020

DOI: 10.5530/jscores.9.2.20

## INTRODUCTION

Urban agriculture is the practice of producing food (plants, mushroom, poultry, aquaculture and livestock) and non-food produce (medicinal plants) within and immediate surroundings of urban limits.<sup>[1]</sup> Urban agriculture has been considered important to achieve urban food security<sup>[2,3]</sup> and sustainability. The multiple functions performed by urban agriculture include supplying fresh produce,<sup>[4]</sup> enhancing resilience,<sup>[5]</sup> social and environmental sustainability,<sup>[6]</sup> short food supply chain,<sup>[7]</sup> urban nutrition, urban greening, social cohesion,<sup>[8]</sup> and effective waste management.<sup>[9,10]</sup> Urban agriculture is also considered to have an important role in reducing urban poverty in the low-income<sup>[11]</sup> and African countries.<sup>[12,13]</sup> In India, urban and peri-urban agriculture has been recognized to be capable of contribution to the alleviation of multiple dimensions of poverty, urban waste management and maintaining ecosystem services.<sup>[14]</sup> The central government scheme entitled 'Vegetable Initiative in

Urban Clusters', started in 2011-12, aimed to address demand-supply gaps for the vegetables in cities<sup>[15]</sup> is, however, no longer operational. To make long term sustainability changes, urban and peri-urban agriculture needs to be integrated into the policy and the development strategies of central and local governments.<sup>[16]</sup>

Bibliometric and scientometrics methods have been used to assess the growth and research trends of different research fields over a period of time. Within urban sustainability and agro-food system studies, scientometric methods have been employed to study the research trends in organic farming,<sup>[17]</sup> agricultural technology,<sup>[18]</sup> global agricultural science research output,<sup>[19]</sup> Indian agricultural research output,<sup>[20]</sup> and urban resilience and sustainability.<sup>[21,22]</sup> However, limited studies have focused on quantifying and analysing the research trends in urban agriculture literature. This study tries to bridge this gap.

## Literature Review

### *Urban agriculture practices*

Urban agriculture ranges from subsistence-based home gardening to commercial production of perishable food items<sup>[4]</sup> Within the urban fringe, agriculture activities may take place in the available pieces of land (public, semi-public

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or private), or on the homestead (roof-tops, balconies, or ground etc.). In many African cities, urban agriculture may also take place in vacant plots and informal land settings such as along the fringes of roads and highways, between highway crossing, below the power lines and surrounding the airport or industrial sites.<sup>[23]</sup> Based on the location, urban agriculture is further classified into urban or intra-urban agriculture and peri-urban agriculture. Urban agriculture literature deals largely with the less sophisticated individual or community urban gardening practices that are entrusted upon self-supply and social well-being, rooftop cultivation (commercial and non-commercial) and the market-led capital intensive urban food production systems.

### Urban gardening practices

Urban gardens are small scale forms of urban agriculture, carried out in public land or private spaces. They can be set up in the ground, in raised beds, plantings in containers or on rooftops,<sup>[24,25]</sup> balconies or patios. Some of the prominent forms of urban gardens include community gardens, allotment gardens, home gardens,<sup>[26]</sup> and rooftop gardens.

Community gardens are gardens managed in open spaces by the local community groups or non-profit organisations.<sup>[27]</sup> The gardening may take place in public land, public parks, private land and school compounds.<sup>[27]</sup> Community gardens are prominent in North America, some European countries and Australia. Allotment gardens are managed by individuals or households on the land parcels allocated to them.<sup>[28,26]</sup> They are prominent in European countries. In the urban setting, home gardens are managed by a single household on the land on the same property or the adjacent vacant lot which is leased, owned or borrowed.<sup>[24,25]</sup> In the global South, home gardening constitutes traditional forms of local agriculture systems where both food and non-food crops are grown.<sup>[29]</sup> Urban home gardening in the North has been overlooked and understudied.<sup>[24,25]</sup>

Urban rooftop cultivation is a type of urban agriculture that is carried out on building rooftops and includes open air gardening and greenhouses.<sup>[30,31]</sup> Rooftop cultivation enables effective use of otherwise unused spaces for cultivation in residential and non-residential buildings in the space-crunch urban areas.<sup>[30,31]</sup> Open air urban rooftop cultivation is carried out for both commercial and non-commercial purposes.<sup>[32]</sup> The term 'Zero acreage farming or Zfarming denotes all forms of urban food production in and on buildings including rooftop cultivation.<sup>[30]</sup> Rooftop gardening is common all over the world<sup>[30,33]</sup> However, their scale and intensity may vary across regions. In Indian cities like Pune and Mumbai, urban rooftop gardens contribute more towards socio-environmental benefits,<sup>[34,35]</sup> whereas in cities like Bangalore, Thiruvananthapuram and Hyderabad, urban rooftop gardens

are also able to supply fresh vegetables and fruits to an extent.<sup>[36-38]</sup> Capital intensive form of urban rooftop cultivation, rooftop greenhouses, is discussed in below.

### Capital-intensive urban agriculture

The capital intensive urban agriculture includes vertical farms and rooftop greenhouses.<sup>[39,40]</sup> These are still in their emerging stage of development. In vertical farming, crops (mostly fruits and vegetables) are cultivated inside a building in vertical layers under controlled conditions. Rooftop greenhouses are greenhouses located on the building rooftops for food production.<sup>[41]</sup> A growing body of literature discusses the rooftop urban greenhouses in North America<sup>[31]</sup> and Europe.<sup>[42-44]</sup> Rooftop Eco-Greenhouses (RTEG) are specific terms given to the rooftop greenhouses that make use of water, energy and CO<sub>2</sub> flows between both the building and the greenhouse.<sup>[42]</sup>

### Urban agriculture and sustainability

A major feature of urban agriculture is the diversity of the socio-economic and environmental functions it offers to sustainability. The sustainability potential attributed to urban agriculture is placed in the context of increasing urbanization<sup>[45]</sup> and linearity of resource flows in urban systems.<sup>[10]</sup> The major concepts associated with urban agriculture and sustainability are food miles, urban green infrastructure and edible city,<sup>[46]</sup> and Continuous Productive Urban Landscapes.<sup>[47]</sup>

Urban agriculture is reported to take place in Australia, North America and many countries across Africa, Asia and Europe.<sup>[48-51,30,52]</sup> The sustainability aspects of urban agriculture vary considerably in the Global South and North. However, much of the studies are based on qualitative data and quantitative measures of urban agriculture outcomes are very limited.<sup>[49]</sup>

In both Global South and North, urban agriculture is focused more on the production of perishable food items like vegetables and milk.<sup>[49]</sup> Inorganic wastes such as plastic bottles and cans are useful in soilless cultivation in urban agriculture.<sup>[53]</sup> Using idle lands, recycled waste water and organic solid waste, urban agriculture can transform from the primarily open loop systems of consumers of resources to more closed loop systems of where the meaning of wastes and resources are blurred.<sup>[10]</sup> However, urban agriculture is also associated with public health concerns due to soil and water contamination.<sup>[54-56]</sup> and the presence of heavy metals in the harvested crops.<sup>[56]</sup>

Although not a major urban economic activity, in the Global South, many studies focus on the role of urban agriculture in contributing to livelihood,<sup>[49,50]</sup> income generation,<sup>[51]</sup> and food and nutrition security in the low-income families.<sup>[48,49]</sup> The

contribution of urban agriculture to food security is mainly through enhancing access to food and income generation.<sup>[48]</sup> Zezza and Tasciotti 2010<sup>[49]</sup> emphasise that urban agriculture is an activity taken up by particular groups and therefore, averages across the urban population may undermine the actual contribution of urban agriculture to these households. Urban home gardens in India have been shown to benefit more from environmental and socio-cultural perspectives than from economic contribution.<sup>[34]</sup>

In the Global North, especially in Europe and the United States, urban agriculture was promoted to enhance food security during the World Wars.<sup>[52]</sup> Presently, urban agriculture has been considered as a means of re-imagining urban spaces to incorporate a multitude of social and environmental values for providing sustainable and socially just urban food systems.<sup>[57]</sup> Although high productivity has been reported from urban home gardens in the Global North,<sup>[58]</sup> the latest research on urban agriculture (2010–2017) has focused more on ecosystem services and biodiversity followed by land management and food security.<sup>[46]</sup>

### Research Objectives

This study aims to explore the global research trends, topical focus and gaps in peer-reviewed journal articles on urban agriculture published in the English language. The data period under study is 2004–2018, i.e. fifteen years.

### Methodology

The study is based on the scientometric analysis of peer reviewed journal articles on urban agriculture. Scientometrics is an analytical tool used to gauge and analysis of publications and research outputs.<sup>[59]</sup> Scientometric studies help to understand growth of a research field, topical and thematic focus of a research field,<sup>[21,60,61]</sup> identification of strengths and weaknesses of research trends and provide better insights to policy makers on the relevance of the research field.<sup>[19]</sup>

### Data source

The study is based on peer-reviewed articles extracted from journals indexed in Scopus database (<http://www.scopus.com>). Scopus is the largest abstract and citation database that cover a wide range of subjects and peer reviewed literature. Journals need to meet and maintain certain criteria to be indexed in the Scopus database so that certain level of quality is assured. However, it is also possible that relevant content published in non-Scopus indexed journals may get excluded from the analysis.

### Data collection

The study retrieved publications data on urban agriculture from the SCOPUS database (<http://www.scopus.com>) on 14<sup>th</sup>

October 2019. The keyword “urban agriculture” was used in the title and keyword strings: (TITLE (“urban agriculture”) OR KEY (“urban agriculture”)). Only keyword and title strings were used as they represent “controlled vocabulary used for document indexation in the SCOPUS base.”<sup>[62]</sup> Searching under the field of “Title/Abstract/Keywords” was avoided as it may result in a huge volume of results that are irrelevant to the given topic.<sup>[60]</sup> However, it is possible that articles dealing with different types of urban agriculture may have been excluded from the SCOPUS search results if they haven’t mentioned “urban agriculture” in their title or keywords.

A total of 1693 documents were obtained for the period of 1978 to 2018. Until 1997, the total number of documents in a year is less than ten and from 1998–2003, the number of documents in a year is between 10–20. As the study focus on analysing the research trends, the data period was restricted to the last 15 years, i.e. 2004–2018, resulting in the exclusion of 148 documents. The study targeted only on original research carried out on urban agriculture. Hence source type was restricted to journals only (13 documents from other source types were excluded) and document types other than articles such as reviews, book chapters, proceedings, editorial etc. ( $n=416$ ) were excluded. Articles published in languages other than English ( $n=95$ ) were also excluded from the analysis. To further refine the data, an additional 70 documents pertaining to 13 subject areas that did not deal with urban agriculture (e.g. Mathematics, chemistry, chemical engineering, computer science, neuroscience etc.) were excluded based on a review of the titles and abstracts. The final data consisting of abstracts and bibliographic information of 951 documents were downloaded in *csv* excel format for further analysis.

### Data analysis

Scientometric and keyword analysis were used for the analysis of the final data. The analysis mainly focused on bibliometric information, topical focus and research gaps. Bibliometric information of the final data was analysed by using SCOPUS. VOSviewer free software was used to find out the bibliographic network visualisation, topical focus and to find out research gaps in urban agriculture studies. Countries with documents five or more are chosen for analysis of co-authorship links with other countries. Similarly, keywords which occurred a minimum five times were used for the analysis of co-occurrence. However, considering the huge occurrence, the keywords “urban agriculture”, “peri-urban agriculture”, urban and peri-urban agriculture etc. were removed from the analysis.

## RESULTS AND DISCUSSION

### Publication pattern

Number of articles, number of citations and h-index are the commonly used scientometric indicators in research evaluation.<sup>[63]</sup> The production of publications is an indicator of the development of a research field.<sup>[64]</sup> Citations reflect (with limitations) the visibility,<sup>[63]</sup> scientific impact and relevance<sup>[65]</sup> of a publication/author/institution/country of the research under evaluation. Citations also measure the focus of fellow researchers' attention<sup>[66]</sup> and its proper use is helpful in providing objectivity to the research evaluation.<sup>[67]</sup> *H*-index is a measure of significance and cumulative research contributions of a researcher.<sup>[68]</sup> "A scientist has index *h* if *h* of his or her  $N_p$  papers have at least *h* citations each and the other ( $N_p - h$ ) papers have  $\leq h$  citations each".<sup>[68]</sup> A researcher having h-index of 10 indicates he/she published ten or more than ten articles and ten of the articles have at least ten citations.<sup>[69]</sup> Irrespective of the number of publications and total number of citation, h-index helps to compare researchers in the same area with approximately same experience level.<sup>[69]</sup> Therefore, higher h-index indicates "greater visibility" of a researcher<sup>[69]</sup> or "more accomplished researcher"<sup>[68]</sup> amongst the researchers with similar number of publications or citation counts. Presently, *h*-index is also used to measure scientific output of research groups, institutions and countries.

Year-Wise distribution of research articles and citations from 2004 to 2018 is shown in Figure 1. Since 2013, the number of articles has increased significantly year by year. Almost all the top fifteen countries show a sudden increase in the number of publications from 2013 onwards. However, the United States shows a sharp increase in comparison to other countries (Figure 2). A total number of citations also shows an increase over the years. Analysis of three years' articles (2016-2018) shows that empirical research on urban agriculture is increasing compared to articles dealing with theoretical aspects. The overall trend in publication output and citation data indicates that urban agriculture has become a focus in the research field and is increasingly gaining attention in the research agenda.

Table 1 shows the top fifteen countries in the production of research articles on urban agriculture. The United States stands first in the number of citations (4094). India stands on 15<sup>th</sup> position with 21 publications and has a total of 102 citations. It is clear from the Table 1 that there is a North-South divide in the publication production on the urban agriculture research. Five countries: United States, United Kingdom, Germany, Canada and Australia: contribute 58 % of total publications of the final dataset. The higher number of publications and citations in these five countries suggest that their research has high scientific impact, relevance, visibility and attention from other researchers. The higher *h*-index values suggest

that these five countries are more accomplished countries in the field of urban agriculture research in terms of cumulative scientific output.

### Most productive journals and research institutions

Table 2 gives the list of most productive journals and institutions in urban agriculture research. As shown in Table 2, the highest number of articles are published in the journals *Land Use Policy* (Netherlands) and *Sustainability* (Switzerland). European-based journals, especially those based in the Netherlands and the United Kingdom, stand at the top in the list of journals with ten or more articles. Universität Kassel, Germany and Universitat Autònoma de Barcelona, Spain (Table 2) are by far the leading research institutions in this field. Altogether, they contribute to twenty percent of the peer-reviewed articles in urban agriculture during the study period. As evident from Table 2, except for the University of Tokyo, all leading research institutions in urban agriculture research are based in Global North.

Post-World War promotion of urban agriculture to address food shortages,<sup>[52,70]</sup> grassroots community gardening initiatives<sup>[70]</sup>, demand for local food systems,<sup>[71]</sup> social justice and public health and public health benefits<sup>[11]</sup> drives urban agriculture in the Global North. Major reasons for increased urban agriculture research in Japan could be its long-term tradition of urban agricultural practices,<sup>[72]</sup> encouragement by government and advocacy groups,<sup>[73]</sup> national legislation enacted in 2015 for promotion of urban agriculture,<sup>[74]</sup>

**Table 1: Publication trend for the top 15 countries for the period of 2004-2018.**

Country/territory	No. of publications	No. of citations	h-index
United States	261	4094	37
United Kingdom	86	1176	21
Germany	82	1031	22
Canada	69	1049	22
Australia	57	687	15
Italy	55	609	14
France	47	395	12
Spain	40	407	13
South Africa	40	377	12
Netherlands	39	400	13
China	31	421	12
Ghana	24	410	12
Sweden	23	432	10
Japan	22	197	7
India	21	102	9

Source: Authors

and potential of urban agriculture as a 'source of disaster preparedness food.'<sup>[72,75]</sup>

### Authorship pattern

The most prominent authors in urban agriculture research in terms of publications number are Andreas Buerkert, (21 articles) and Joan Rieradevall, (17 articles). These two authors come from the top two productive institutions in urban agriculture research, i.e. Universität Kassel and Universitat Autònoma de Barcelona, respectively. Six authors have more than ten research articles, contributing approximately nine percentage of the research articles on urban agriculture.

Among these six, three authors are from Spain, two are from Germany and one author is from the United States. The co-authorship networks are also concentrated mostly in Global North, especially in the United States, United Kingdom, Germany, Australia, Canada. Although there are a few countries from the Global South, the research on urban agriculture is largely centred in the Global North.

The overlay analysis shows co-occurrence over a particular period. Overlay analysis of countries with more than ten articles shows that compared to other countries, Nigeria, Kenya and Ghana have started research in urban agriculture before 2012. However, their contribution to urban agriculture publications is comparatively lower than many other countries who have

come to this field at a later stage. Further research is required to understand this situation. Although Canada has started urban agriculture publication in 2012 followed by Australia in 2013, the top three countries in the list of most productive countries (United States, United Kingdom and Germany) have entered in urban agriculture research only at a later stage.

### Access type

The term open access in scientific publications refers to online or digital publications that have unrestricted access without any price barriers and free of most copyright and licencing restrictions.<sup>[76]</sup> This helps in the dissemination of the research to those who do not have the subscription access to the article. The international efforts to make open access publication of COVID-19 research<sup>[77,78]</sup> is the recent example that shows the importance of free and unrestricted access to scientific findings for rapid dissemination of knowledge. Compared to subscription access articles, open access articles receive increased attention, downloads and shares.<sup>[79,80]</sup>

Among the final dataset of 951 documents, 175 articles are open access publications, indicating that 18.4% of the articles on urban agriculture are freely available to the readers. The open access journal *Sustainability* (Switzerland) is the lead producer of publications (31) followed by WIT Transactions on Ecology and the Environment (14) and Agronomy for Sustainable Development (8). These three journals also find

**Table 2: Leading journals and institutions in the area of urban agriculture research (2004-2018).**

Journal	No. of publications	Affiliation	No. of publications
Land Use Policy	36	Universität Kassel, Germany	26
Sustainability Switzerland	31	Universitat Autònoma de Barcelona, Spain	21
Landscape And Urban Planning	27	Wageningen University and Research Centre, The Netherlands	18
Agriculture And Human Values	22	Ohio State University, USA	17
Local Environment	21	UAB Institut de Ciències i Tecnologia Ambientals, Spain	17
Renewable Agriculture And Food Systems	19	INRA Institut National de La Recherche Agronomique, France	15
Wit Transactions On Ecology And The Environment	16	Michigan State University, USA	14
Agronomy For Sustainable Development	14	University of Guelph, Canada	13
Future Of Food Journal On Food Agriculture And Society	14	University of Tokyo, Japan	13
Science Of The Total Environment	13	Alma Mater Studiorum Università di Bologna, Italy	13
Urban Forestry And Urban Greening	13	Institut de Recerca i Tecnologia Agroalimentaries, Spain	13
-	-	Universität Göttingen, Germany	13

Source: Authors

a place in the top ten journals in terms of the number of publications in urban agriculture. VOS viewer analysis of the open access articles shows that most of the authors are from Global North. United States, Italy, Germany, United Kingdom and Canada are the top producers of open access articles. Deliberate policy interventions in the North American and European countries<sup>[81-83]</sup> contribute to higher number of open access publications from these countries. These countries are also signatories to “OECD Declaration on Access to Research Data from Public Funding” adopted in 2004.<sup>[84]</sup>

### Topical focus and highly cited papers

Most of the research on urban agriculture belongs to the subject area Social Sciences (509) followed by Environmental Science (456) and Agricultural and Biological Sciences (313). Table 3 shows the top ten articles with highest citations. These top ten most cited articles contribute 12.74% of total citations received by the entire dataset for the study period. Except two, most of these articles were published during 2008–2014. Only one of the most cited ten articles is open access, indicating that the increased citation was not due to the high visibility comes

with open access. It could be possibly due to the increased research attention on urban agriculture. The highly cited articles (Table 3) focus on exploring social or environmental benefits of urban agriculture by employing theoretical ( $n=3$ ), empirical ( $n=3$ ), or both ( $n=4$ ) approaches. This suggests that theoretical and empirical analysis of urban agriculture have equal importance to many researchers in this field.

Most of the highly cited papers with citations 100 or above are from the Global North and the USA has a considerable presence in this list. Only one paper from the Global South (Japan) has received citations above 100. This again indicates that the contribution of Global North has a high impact on urban agriculture research.

### Keyword analysis

Keywords are indicators of research focus and core contents of an article.<sup>[85]</sup> Keywords can provide an overview of the concepts<sup>[86]</sup> and the development of a research field over time.<sup>[87]</sup> As this study adopted full counting method in VOS viewer analysis, occurrences indicate the total number of times a term or keyword appeared in all the documents.<sup>[88]</sup> A total of

**Table 3: Most cited papers (2004-2018).**

Authors and publication year	Title	Source title	Country of affiliation	Times cited
Jaros, 2008	The city in the country: Growing alternative food networks in Metropolitan areas	Journal of Rural Studies	USA	241
Saldivar-Tanaka and Krasny, 2004	Culturing community development, neighbourhood open space and civic agriculture: The case of Latino community gardens in New York City	Agriculture and Human Values	USA	235
Zeza and Tasciotti, 2010	Urban agriculture, poverty and food security: Empirical evidence from a sample of developing countries	Food Policy	Italy	228
McClintock, 2014	Radical, reformist and garden-variety neoliberal: coming to terms with urban agriculture's contradictions	Local Environment	USA	195
McClintock, 2010	Why farm the city? Theorizing urban agriculture through a lens of metabolic rift	Cambridge Journal of Regions, Economy and Society	USA	172
Baker, 2004	Tending cultural landscapes and food citizenship in Toronto's community gardens	Geographical Review	Canada	154
Barthel and Isendahl, 2013	Urban gardens, Agriculture and water management: Sources of resilience for long-term food security in cities	Ecological Economics	Sweden	146
Grewal and Grewal, 2012	Can cities become self-reliant in food?	Cities	USA	140
Specht <i>et al.</i> 2014	Urban agriculture of the future: An overview of sustainability aspects of food production in and on buildings	Agriculture and Human Values	Germany	131
Tornaghi, 2014	Critical geography of urban agriculture	Progress in Human Geography	UK	127

Source: Authors

2680 unique author keywords were extracted with a total of 4761 occurrences. However, only 11% ( $n=526$ ) of the total keywords have occurred more than one time, 2% of the total keywords have appeared more than five times and 0.6 % of the total keywords occurred more than ten times. Table 4 shows the top five author keyword sin addition to the keywords ‘urban agriculture’ and ‘peri-urban agriculture’.

Keywords co-occurrence indicate the development of a specific research field and current research trends.<sup>[89]</sup> Keyword co-occurrence refers to the number of articles in which two keywords occur together in the same article<sup>[88]</sup> and indicate the network linkages or relations of the keywords. Keywords that occur together in an article have stronger relations to each other and represent the core focus of the article.<sup>[90]</sup>

VOS viewer software was used to analyse keyword co-occurrence to illustrate the research hotspots in urban agriculture. After keeping the threshold to five keywords, a total of 100 keywords that are connected to each other were

brought into the visualisation using VOS viewer (Figure 3). The size of the labels and circles in Figure 3 indicates the number of occurrences of the keywords. Keywords that have appeared together are connected with a link represented as lines. The total link strength of keyword co-occurrence is the cumulative strength of the links of a keyword with other keywords.<sup>[88]</sup> Keywords with higher value for total link strength indicate that these keywords have more tendency to occur together in comparison to keywords with lesser value for total link strength. The topic similarity and relative strengths are represented by the distance between two keywords.<sup>[64]</sup> As Figure 3 and Table 4, the major focus areas of the urban agriculture research are a) food security) b) sustainability c) community gardens d) urban planning and e) urban farming. The total link strength provided in Table 4 indicates that tendency of keywords to co-occur could be higher even with comparatively less occurrences.

Apart from the most prominent keyword ‘urban agriculture’, other keywords that indicate urban agriculture typologies included different types of gardening, peri-urban agriculture and building-integrated production (rooftop production, vertical farming, etc.). The keywords that denote gardening mainly comprises of allotment gardening, community gardening and home gardening. Peri-urban agriculture was also denoted by other keywords such as urban-and peri-urban agriculture. Building-integrated production was denoted by keywords such as rooftop gardens, rooftop greenhouses, green roofs and vertical farming.

**Table 4: Major keyword occurrences and their link strength.**

Keyword	Occurrences	Total link strength
urban agriculture	530	624
peri-urban agriculture	63	50
food security	61	128
sustainability	43	80
community gardens	31	60
urban planning	26	51
urban farming	26	36

Source: Authors

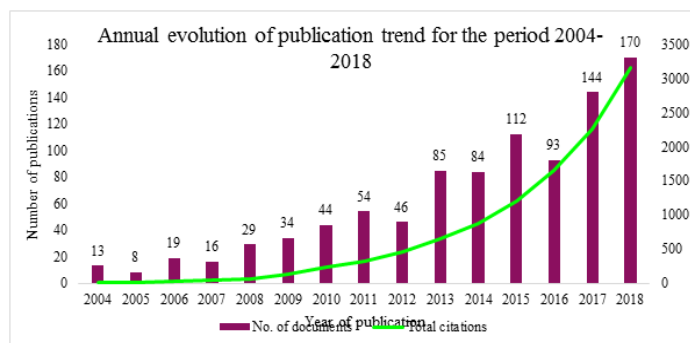
**Table 5: Major research focus of the keyword clusters.**

Cluster Number	Number of keywords	Major research focus of the clusters
1	14	Gender and poverty related to urban agriculture especially in African countries
2	13	Planning, policy and governance related to multifunctional aspects of urban agriculture
3	12	food justice, food safety and urban development related to urban gardening
4	12	ecosystem services catered by building-integrated urban agriculture
5	10	socio-environmental sustainability aspects of community gardens
6	10	urban agriculture and climate change
7	9	food production
8	8	Agro ecological and food sovereignty aspects of urban agriculture
9	7	capital-intensive urban agriculture
10	5	food security, livelihoods and urban poverty especially in African countries

Source: Authors

### Keyword clustering

Figure 5 demonstrates ten distinct clusters or subfield to urban agriculture keywords. The circles in the same colour forms a cluster and suggest similarity of the topics among these articles. Each cluster represents a subfield of urban agriculture research. Major research focus of the ten clusters are provided in Table 5.

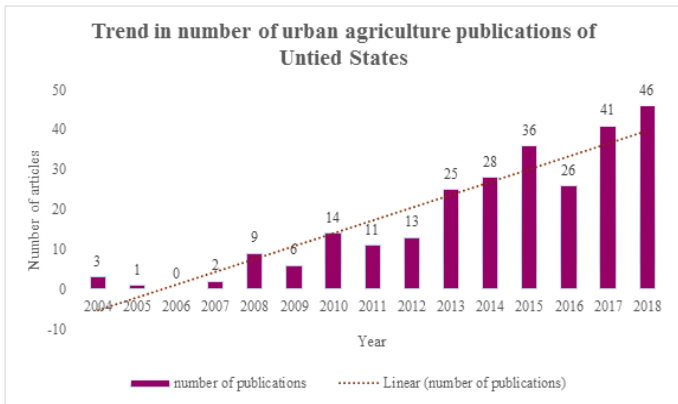


Source: Authors

**Figure 1:** Publication and citation output for the period 2004-2018.

### Evolution of keywords in urban agriculture articles

As shown in Figure 4 and Figure 5, keywords such as Nigeria, South Africa and Ghana have an average publication year between 2009 and 2010. Despite the relatively early appearance in urban agriculture publications, their occurrence is very less (between 5 and 10). The analysis doesn't show any keyword co-occurrences before 2009. Other keywords, despite the number of occurrences, keywords emerged during the middle five-year period of the study time, i.e. 2009–2013, are broadly related to poverty, gender, gardening and sustainability. Gradually, in the later years of the study period (2014–2018), the urban agriculture publications started to look into research on climate change, urban sustainability, urban planning, community gardening, food justice movements and different



Source: Authors

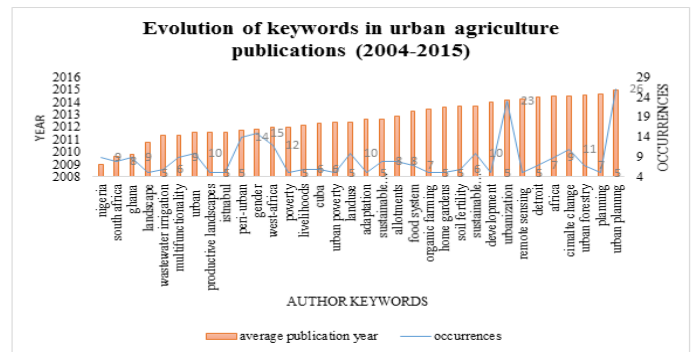
**Figure 2:** Linear trendline showing an increase in the number of publications of the United States.

technologies of production (rooftop greenhouse, vertical farming, hydroponics etc.).

### Gaps in urban agriculture research

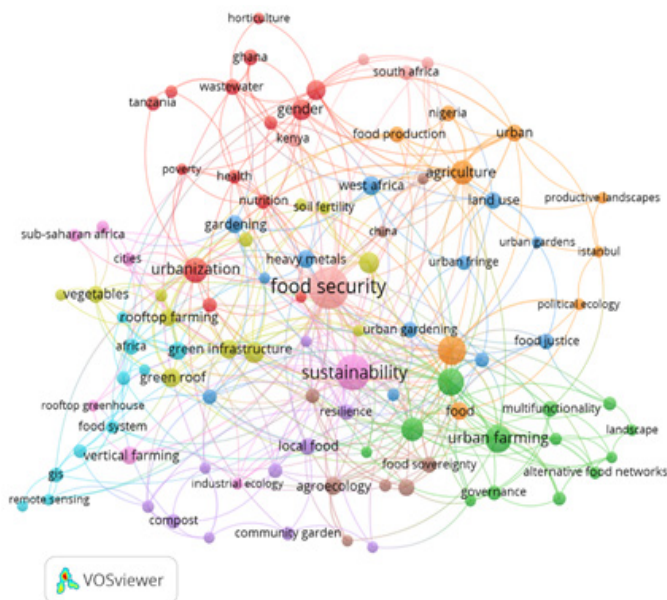
The study has identified two major gaps in urban agriculture research for the study period of 2004–2018. As mentioned earlier, the major contributors to urban agriculture research are the countries and research institutions from the Global North. Although there are review papers that deals with urban agriculture in the Global South,<sup>[9,51]</sup> representation of original research work from the institutions of Global South has been comparatively less in the peer reviewed journal articles published in the English language.

The focus of urban agriculture publications is largely centred upon food security and sustainability. In recent years, articles on urban agriculture have also started to look into community gardening, urban planning, climate change, food justice and new forms of production within the limitations of the urban area. This indicates a shift in research focus to explore socio-environmental sustainability potential of urban



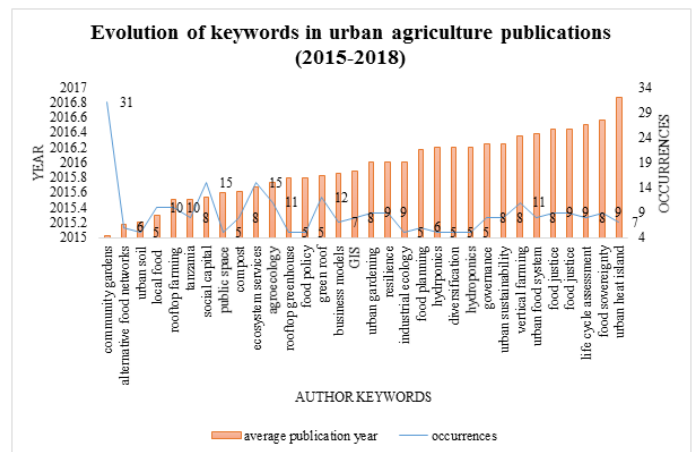
Source: Authors

**Figure 4:** Evolution of keywords in urban agriculture publications (2009-2015).



Source: Authors

**Figure 3:** Co-occurrence of author keywords.



Source: Authors

**Figure 5:** Evolution of keywords in urban agriculture publications (2015-2018).



agriculture. Despite the potential of urban agriculture, there is less academic focus on urban agriculture governance frameworks.<sup>[8]</sup> One possible reason could be the informal character of urban agriculture initiatives. Policy formulation is the first step in planning to make urban agriculture the integral part of urban development goals.<sup>[16,91]</sup> Although urban planning is one of the major keywords used in urban agriculture articles for the study period, there is negligible mention on governance and policy. The lack of recognition of urban agriculture as a formal agricultural land use type and lack of its integration into government policies might risk the efficacy and sustainability of urban agriculture initiatives.<sup>[92]</sup>

## CONCLUSION

This paper tried to explore research trends, focus and gaps in urban agriculture articles published in peer-reviewed articles in English from 2004 through 2018. The paper showed that urban agriculture has been increasingly gaining attention in the research agenda with a sudden rise in research articles from 2013 onwards. Although there are a few countries from the Global South, the research on urban agriculture is largely centred in the Global North. The United States predominate in the production of articles on urban agriculture. A previous study has revealed that the United States also tops in the publications in agricultural science.<sup>[19]</sup> Post-war food shortages and demand for urban sustainability and social justice are the driving factors for increased urban agriculture activities in many of the countries in Global North.

Although Nigeria, Kenya and Ghana have started to publish research articles in urban agriculture before 2012, their contribution remains comparatively lower than other countries (especially those from the Global North) who have started publication at a later stage. Further research is needed to understand why there is less representation of Global South in peer-reviewed research on urban agriculture.

European-based journals, especially those based in the Netherlands and the United Kingdom, are leading in the publication of urban agriculture articles. Universität Kassel, Germany and Universitat Autònoma de Barcelona, Spain are the top two leading research institutions in this field. The most productive authors in urban agriculture research (Andreas Buerkert and Joan Rieradevall) also come from these top two institutions. Except for the University of Tokyo, all leading research institutions in urban agriculture research are based in the Global North. The highly cited papers also come from research institutions in the Global North.

Most of the research in urban agriculture is carried out in the subject area of Social Sciences. The major keywords (other than urban agriculture and peri-urban agriculture) used in urban agriculture articles are food security, sustainability,

community gardening, urban planning and urban farming. Apart from urban agriculture, major urban agriculture typologies are gardening, peri-urban agriculture and building-integrated production (rooftop production, Z-farming, etc.). The keywords that emerged in the recent years (2014–2018) include climate change, urban sustainability, urban planning, community gardening, food justice movements and different technologies of production (rooftop greenhouse, vertical farming, hydroponics etc.). Keyword analysis signals a recent shift in research focus towards exploring socio-environmental sustainability potential of urban agriculture. Although urban agriculture research is centred upon food security and sustainability, there is negligible mention on policy and governance within the English language peer-reviewed journal articles on urban agriculture during 2004–2018. Considering the sustainability potential of urban agriculture, this study points towards the importance of integration of urban agriculture into agricultural and urban development policies.

## ACKNOWLEDGEMENT

An earlier version of this paper has been presented in the 45<sup>th</sup> All India Sociological Conference held in Thiruvananthapuram in December 2019. The authors would like to thank the organisers for the opportunity to present the paper.

## CONFLICT OF INTEREST

The authors declare no Conflict of interest.

## ABBREVIATIONS

**Z-forming:** Zero acreage farming.

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