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Bibliometric Analysis of Urban Farming

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ABSTRACT

Urban farming has emerged as an important research area in response to increasing urbanization, food security challenges, and the need for sustainable agricultural systems. This study aims to examine the development, intellectual structure, collaboration patterns, and emerging research trends in urban farming literature using a bibliometric analysis approach. Data were collected from the Scopus database using relevant keywords related to urban farming and analyzed through performance analysis and science mapping techniques with VOSviewer. The analysis covers publication trends, highly cited literature, author collaboration, institutional and country networks, keyword co-occurrence, temporal evolution, and research density patterns. The findings indicate that urban farming research has evolved from a focus on peri-urban agriculture, land utilization, and sustainable food production toward technology-driven approaches involving vertical farming, hydroponics, smart agriculture, Internet of Things (IoT), artificial intelligence, and machine learning. The collaboration analysis reveals that urban farming research is globally distributed, with countries such as Indonesia, the United States, China, India, Germany, and the United Kingdom serving as important knowledge contributors. The keyword analysis further demonstrates that sustainability, food security, and technological innovation represent the dominant themes shaping the field. This study contributes to a better understanding of the intellectual development of urban farming research and identifies future opportunities for integrating digital technologies, sustainability strategies, and inclusive urban agricultural policies.

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1. INTRODUCTION

Urbanization has become one of the major phenomena in the world, which influences the food systems of our time, the environmental sustainability and the development of cities [1], [2]. Growth in the number of people in urban areas has put pressure on traditional agricultural systems because of lack of space, growing food requirements and increased vulnerability of food supply chains [3]. As reported by the United Nations, currently more than 50 percent of the world population lives in urban areas, and this number will keep growing in the coming decades [3], [4]. The phenomenon has become a source of many problems

regarding food security, natural resources management and urban sustainability. In order to address this issue, urban agriculture has been introduced as an alternative to traditional agriculture, which brings the production process into urban areas in order to enhance food production locally and promote sustainable development goals [5]. Urban agriculture is a complex notion which includes roof agriculture, vertical farming, community gardening, hydroponics, aquaponics and many others production techniques.

Apart from providing food for consumption, urban agriculture is becoming more and more popular due to its environmental, economic, and social advantages. Environmentally, urban agriculture can help minimize transportations between producers and consumers of food and therefore decrease food-related carbon emissions and facilitate the development of local food system [6], [7]. Additionally, urban agriculture has also proved to be helpful in increasing biodiversity, enhancing urban ecosystem services and better use of underutilized urban areas [8]. Economically, urban agriculture can provide employment opportunities and support entrepreneurship in urban areas. Socially, urban agriculture can enhance social cohesion, ensure better access to food and engage people in sustainable activities [9]. All these features make urban agriculture one of the important research domains of sustainability science, urban studies, environmental management, agricultural innovations and public policies.

Technological advancement and innovation have also played a very critical role in the development of urban farming practices. Application of modern technologies in agriculture such as Internet of Things (IoT), artificial intelligence, automation, hydroponics, and controlled environment agriculture has increased the scope of urban farming practice by overcoming some of the challenges faced in urban areas due to scarcity of land and high productivity [10]. For instance, vertical farming technology has made it possible to cultivate crops in dense urban areas using multi-layered farming system. In addition, digital technologies have made it possible to monitor resources and increase efficiency in production. This has made researchers across different disciplines including agriculture, engineering, IT, environment, economics, and social sciences to carry out interdisciplinary research on urban farming. As a result of this, the academic literature on urban farming has increased significantly.

Although the rising popularity of urban agriculture is evident, current literature demonstrates that the progress in this research area is rather scattered among different research fields and geographic regions. Previous studies have considered different dimensions of urban agriculture, such as food security, sustainability evaluation, community empowerment, technology innovations, and policy implementation. Nonetheless, the heterogeneity of the perspectives and methodologies used leads to the complexity of the knowledge base that needs to be investigated systematically. Literature reviews can offer meaningful theoretical insights but often lack an ability to detect trends in a large set of publications, identify influential studies and collaborative networks, and track new research trends. Hence, bibliometric analysis becomes a suitable methodology to investigate the evolution and intellectual structure of the research on urban farming. Bibliometric approaches help researchers to conduct quantitative analysis of scientific papers using different indicators, such as publication trends, citation performance, keyword development, co-authorship networks, and thematic evolution [11].

The use of bibliometric analysis has been of utmost importance in new and interdisciplinary research areas due to the provision of a complete overview of the growth of knowledge and the identification of future research possibilities. Using bibliometric analysis, one can identify key themes, key players, international cooperation trends, and the gaps in a particular field of study. This is especially true for urban agriculture since this field develops in line

with the global problems of climate change, food security, sustainable cities, and technological revolution. While there is a number of studies focusing on different aspects of urban agriculture, a bibliometric analysis providing an insight into the overall development, structure of intellect, and future prospects of urban agriculture research is still lacking.

Despite the considerable attention given to the issue of urban agriculture by scholars, the current knowledge base in the field still appears fragmented, as it belongs to various disciplines, research methods, and approaches. The lack of a thorough assessment of research development leads to difficulties in tracking how the field develops, which issues prevail within it, which theoretical frameworks guide current researches, and what areas remain understudied and open for further investigation. Hence, the necessity for a systematic bibliometric study that would help discover the patterns of publication activity, key research results, collaboration patterns, and new directions in urban farming research arises.

This paper intends to carry out the bibliometric analysis of the urban farming research by analyzing publication patterns, citation practices, prominent authors and sources, network of international collaborations, and thematic advances of the field. In particular, the current study intends to map out the structure and evolution of urban farming research by using bibliometric mapping tools. It is hoped that the findings of the present study will be beneficial for the existing literature by giving an insight into the research development, novel areas of research, and future directions of research.

2. METHODS

The current research uses the approach of bibliometric analysis to analyze in detail the development, intellectual structure, and research trends within the area of urban farming. Bibliometric analysis represents a quantitative research methodology, which makes use of statistical and visualization methods applied to scientific publications with the aim to reveal patterns of knowledge development, important contributions, collaboration networks, and new research areas [11]. The chosen method is explained by the fact that the field of urban farming is an interdisciplinary area of research that includes different perspectives like agriculture, sustainability, urban planning, environmental management, technologies, and social sciences.

The process of collecting the data was carried out through the use of the Scopus database as the principal source of scientific papers. The choice of Scopus as the main tool for searching was justified by the fact that this database contains wide coverage of peer-reviewed scientific works and reliable metadata, which includes such parameters as information about publications, authors of the works, citations, keywords, and affiliations of authors to certain institutions. The search strategy was built based on the use of appropriate keywords that are connected with urban farming, such as “urban farming,” “urban agriculture,” “city farming,” and “urban food systems.” The search was carried out taking into account publications within the specified time period and certain document types.

Bibliographic data collected were analyzed through bibliometric metrics and visualization. Among others, the following metrics were used in this process: growth trend of publications, citation analysis, productivity of sources and authors, collaboration among countries, analysis of co-occurrence of keywords, and thematic mapping. Network visualization and clustering methods using VOSviewer software were used to analyze the relationships between keywords, authors, and countries [12]. Also, thematic analysis was carried out to determine major research clusters and emerging themes in urban farming research.

3. RESULT AND DISCUSSION

3.1 Co-Author Analysis

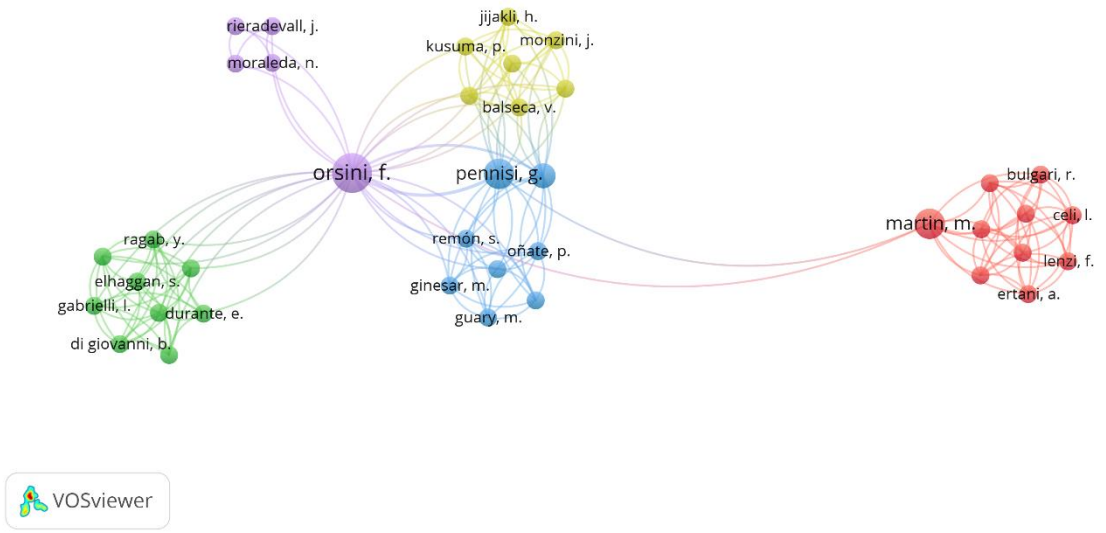

Figure 1. Author Visualization
Source: Data Analysis

Figure 1 shows the knowledge network connections between authors in the research area of urban farming. It can be seen from the figure that there are a number of separate clusters of collaboration which are shown in different colors and represent groups of co-operating authors. The biggest and the most connected cluster includes Orsini, F., who serves as an important center of collaboration bringing different research groups together. This fact shows that Orsini plays a major part in urban farming research and particularly in collaborations with respect to sustainable urban agriculture, controlled environment agriculture, and food production systems. Other notable collaboration centers are Pennisi, G., Remón, S., and Martin, M., who show high connectivity within their research networks. The existence of several clusters shows that urban farming research was built upon specialized research teams working in particular areas of research.

The network diagram further shows that collaboration within the urban agriculture research is spread across international borders yet maintains the separation of academic communities. The research group characterized by the red cluster of authors, such as Martin, M., Bulgari, R., and Celi, I. is distinct in terms of its collaboration because it is poorly connected to any other cluster whereas the green, yellow, blue, and purple clusters are characterized by more interdisciplinary links. The lines between clusters indicate the flow of knowledge among research groups despite the existence of gaps in collaboration. Therefore, the future urban agriculture research may profit from further international and interdisciplinary collaboration.

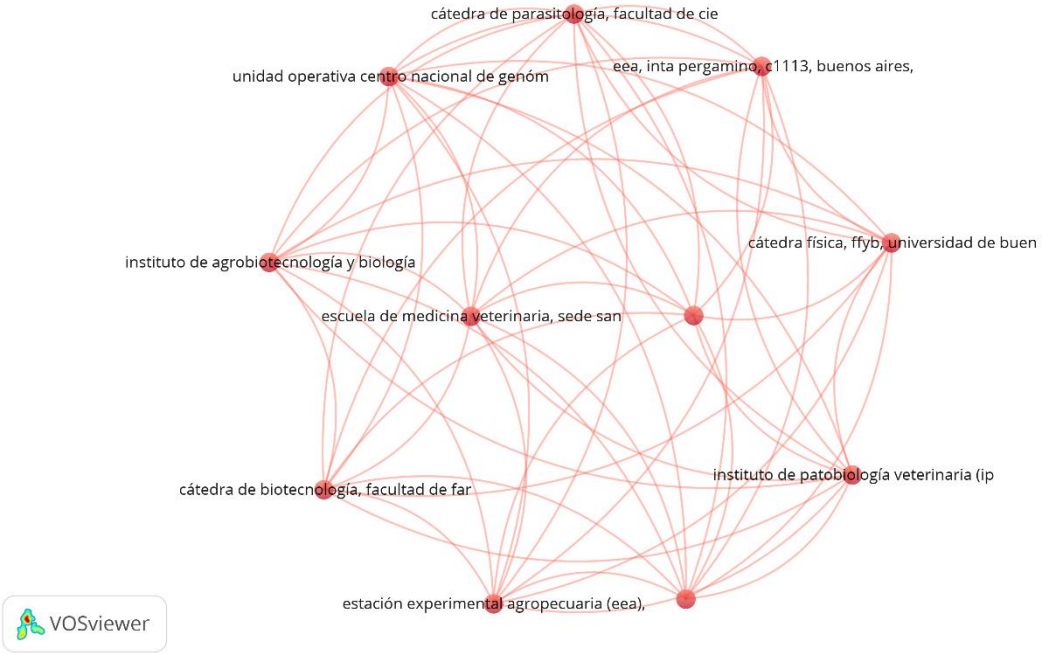

Figure 2. Institution Visualization
Source: Data Analysis

Figure 2 demonstrates the high level of interconnection in the research network of institutions that conduct research on the subject of urban farming. One can observe the presence of one single dominant cluster of collaborations, which means a great deal of collaboration in the network of institutions as opposed to the presence of isolated groups of researchers. Several institutions such as Instituto de Agrobiotecnología y Biología, Estación Experimental Agropecuaria (EEA), Instituto de Patobiología Veterinaria, and Facultades of universities are interconnected through numerous links. A high density of relations reveals that research is carried out through the collaboration of interdisciplinary teams of scientists including agricultural, biotechnological, veterinary, and biological research institutions. Therefore, research on the subject of urban farming is based on institutional networks that involve diverse scientific approaches especially in sustainable production systems and agriculture.

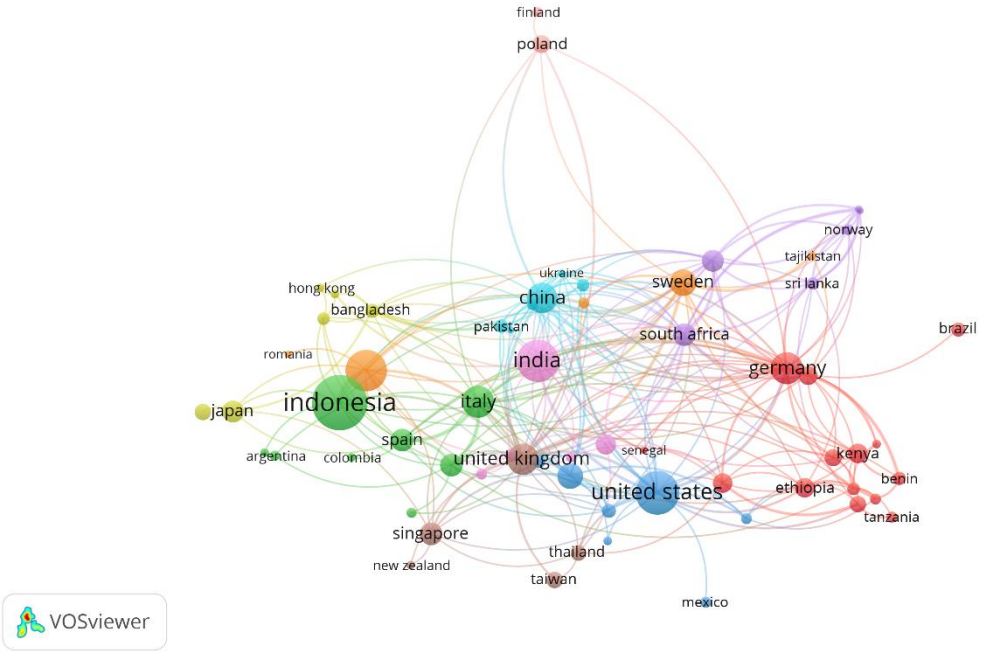

Figure 3. Country Visualization
Source: Data Analysis

Figure 3 highlights the global presence and international collaboration trends in urban agriculture research. From the figure below, one can observe that the research efforts are highly clustered around specific countries, and Indonesia, the USA, China, India, Germany, and the UK feature as the main nodes owing to their relatively large sizes and numerous links. These countries act as the main research centers which make a significant contribution to the process of knowledge generation and international collaboration. The position of Indonesia is quite strong within the network, suggesting the increasing trend of research contributions and collaborations with other countries including Italy, Spain, Japan, and other countries in Asia and Europe.

The network also shows how multidisciplinary and multi-geographical the field of urban farming research is. Some clusters of countries working together could be identified, including cooperation between Asian countries (Indonesia, China, India, Japan, and Singapore), European countries (Germany, Sweden, Norway, Poland, and the UK), and African countries (Kenya, Ethiopia, Tanzania, and South Africa). The existence of links connecting these clusters signifies that there are connections between countries from different geographical areas in terms of research collaboration, indicating that urban farming research is treated as a worldwide problem associated with food security, sustainable urban development, adaptation to the changing climate, and agriculture resilience. Nevertheless, the uneven node sizes and connection strength point out that research collaboration is dominated by several countries only.

3.2 Citation Analysis

Table 1. Top Cited Literature

Citations	Authors and Year	Title
624	[13]	Multifunctional peri-urban agriculture-A review of societal demands and the provision of goods and services by farming
316	[14]	Farming in and on urban buildings: Present practice and specific novelties of zero-acreage farming (ZFarming)
297	[15]	Urban myths of organic farming

280	[16]	Farming up the city: The rise of urban vertical farms
219	[17]	Adoption of the Internet of Things (IoT) in agriculture and smart farming towards urban greening: A review
202	[18]	Environmental assessment of small-scale vegetable farming systems in peri-urban areas of the Yangtze River Delta Region, China
158	[19]	Indoor vertical farming in the Urban nexus context: Business growth and resource savings
157	[20]	Heavy metal accumulation and health risk assessment in wastewater-irrigated urban vegetable farming sites of Addis Ababa, Ethiopia
148	[21]	Environmental assessment of an urban vertical hydroponic farming system in Sweden
145	[22]	IoT based smart agrotech system for verification of Urban farming parameters

Source: Scopus 2026

Table 1 provides an indication of the development of the field, moving from multifunctional agriculture and sustainability angles to technology-oriented urban agriculture production systems. The most cited paper by [13] (624 citations) draws attention to the multifunctional nature of peri-urban agriculture as a sector capable of meeting the needs of society and providing ecosystem services. This is the indication that the initial research of urban agriculture was largely focused on land use, environmental benefits, and the social functions of this phenomenon. Highly cited papers by [14] and [23] dealing with zero-acreage farming and vertical farming, respectively, show an emerging interest among academics in innovative methods of implementing agriculture into the city, using building- and vertical-based production. Another set of highly cited papers is devoted to the sustainability assessment of urban farming, its environmental effects, resource efficiency, and health risks [20], [24] . In addition, the recent highly cited papers by [17] and [22] evidence that another research avenue for urban agriculture is the application of smart farming technologies, including the Internet of Things and automation.

3.3 Keyword Co-Occurrence

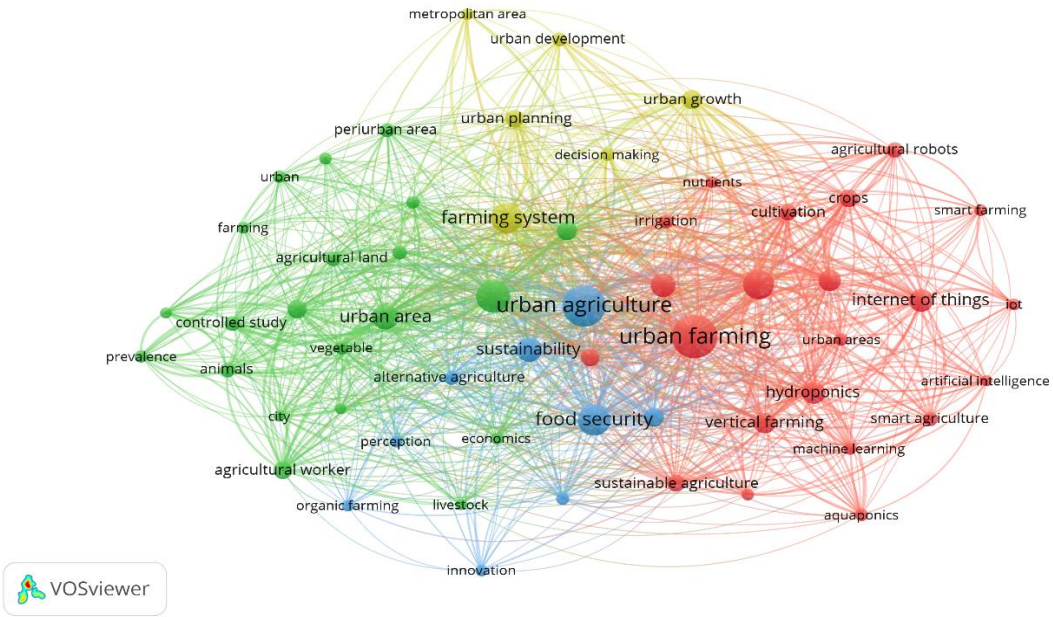

Figure 4. Network Visualization
Source: Data Analysis

The illustration presented in Figure 4 shows the theoretical framework and research focus areas associated with urban farming. As can be seen from the figure, the term "urban farming" is the main keyword in this field of study due to the high node size, which demonstrates its dominant role and frequent usage. It should also be noted that urban farming is strongly connected with other keywords such as urban agriculture, sustainability, food security, vertical farming, hydroponics, smart farming, and Internet of Things (IoT), which proves the interdisciplinary nature of urban farming research.

Clustered in red is the technology aspect of urban farming studies. The use of terms such as vertical farming, hydroponics, smart farming, Internet of Things, artificial intelligence, machine learning, robots in agriculture, and aquaponics highlights a rising trend of research in the use of technology to enhance urban farming practices. Such a cluster is indicative of the development of urban agriculture from traditional approaches to more efficient and technologically-driven farming models. The connection between such terms shows that the utilization of digital technology has become a key approach to overcoming issues posed by limited space for urban farming and increased food demand.

The cluster of "green" focuses on the ecological, agricultural and social aspects of urban farming. The keywords such as urban agriculture, agricultural land, farming system, vegetable, organic farming, livestock, agricultural worker, and peri-urban area demonstrate that scholars still study urban farming based on the aspect of traditional agricultural practices and the introduction of these practices into the urban landscape. The cluster points out the importance of the involvement of urban farming in improvement of local food systems, usage of urban/peri-urban areas for the agricultural purposes, community agriculture and environment sustainability. The relationship between urban farming and sustainability in this cluster proves that urban agriculture is often seen as an alternative way of city building.

The blue cluster shows the focus on sustainability and food security within urban farming research. The presence of keywords like food security, sustainable agriculture, innovation, economics, and sustainability indicates that urban farming is being studied increasingly as a solution to some of the challenges faced globally, such as food accessibility and climate change adaptation, among others. The close association between food security and urban agriculture highlights the fact that urban farming has been seen as a possible solution for decreasing reliance on food systems far away from the city centers and increasing food security in urban areas.

The yellow cluster reflects the relationship between urban farming and urban planning perspectives. Keywords such as urban planning, urban development, urban growth, metropolitan area, and decision making indicate that urban farming research has expanded beyond agricultural science into urban policy and spatial management. This theme highlights the importance of integrating agricultural activities into city planning frameworks to optimize land use and support sustainable urban growth.

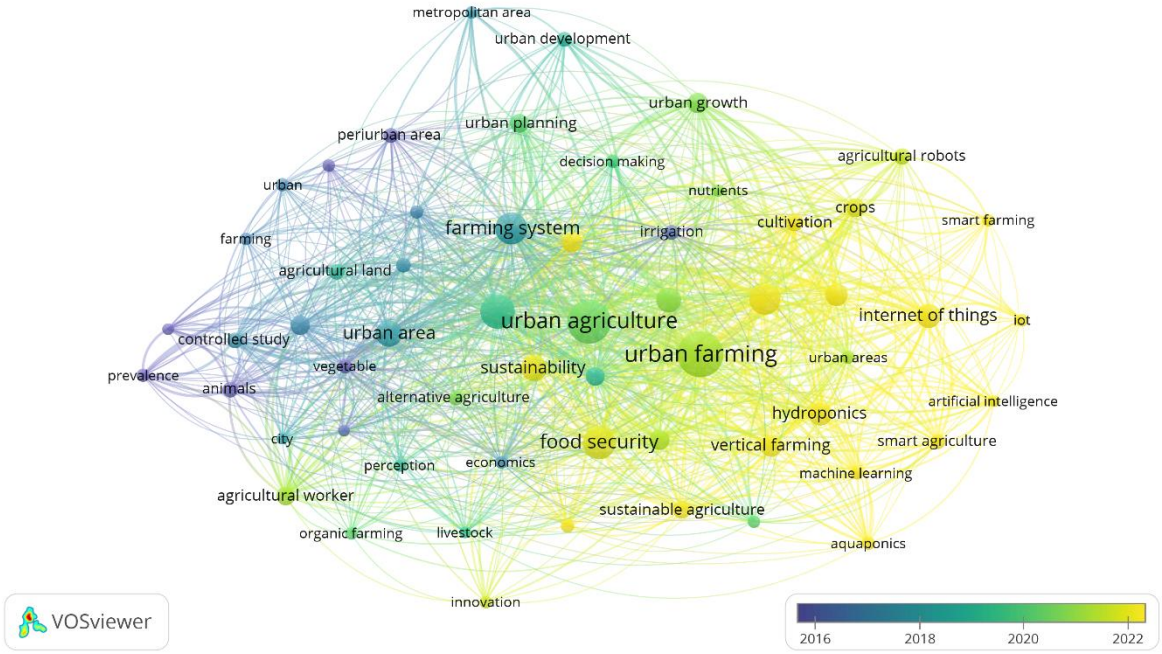

Figure 5. Overlay Visualization
Source: Data Analysis

The research themes temporal progression is represented by Figure 5 using the keyword frequency and average year of publication. In this figure, the color scale shows how the research themes changed over time, where dark blue keywords indicate older research themes and green and yellow keywords newer emerging themes. As seen in this figure, there were older research themes about urban agriculture, farming systems, agricultural lands, peri-urban areas, and urban development. This shows how the initial focus was on understanding the importance of agriculture in the urban setting and land use in the context of food production and urban expansion.

More current research trends are shown by the keywords in yellow color, specifically those associated with technology innovations and intelligent farming systems. Keywords like Internet of Things (IoT), artificial intelligence, machine learning, smart farming, vertical farming, hydroponics, aquaponics, and agricultural robots show the trend of urban farming adopting more technology-related innovations. This shows that current researches in urban farming are increasingly adopting digital solutions to improve productivity and efficiency in urban farming. It is clear that there are challenges that researchers are trying to solve through urban farming research.

The trend in time also reflects the shift from the spatial and ecological focus of urban agriculture research to an integrative view of sustainability and innovation. It is evident from the recent trends in urban agriculture, food security, sustainability, and sustainable agriculture that the current studies regard urban agriculture as a solution to global sustainability problems. Since the increasing focus on technology, along with environmental and social aspects, reflects a new trend in research, one can suggest that the future studies will address the integration of smart technology, circular economy, and urban policies.

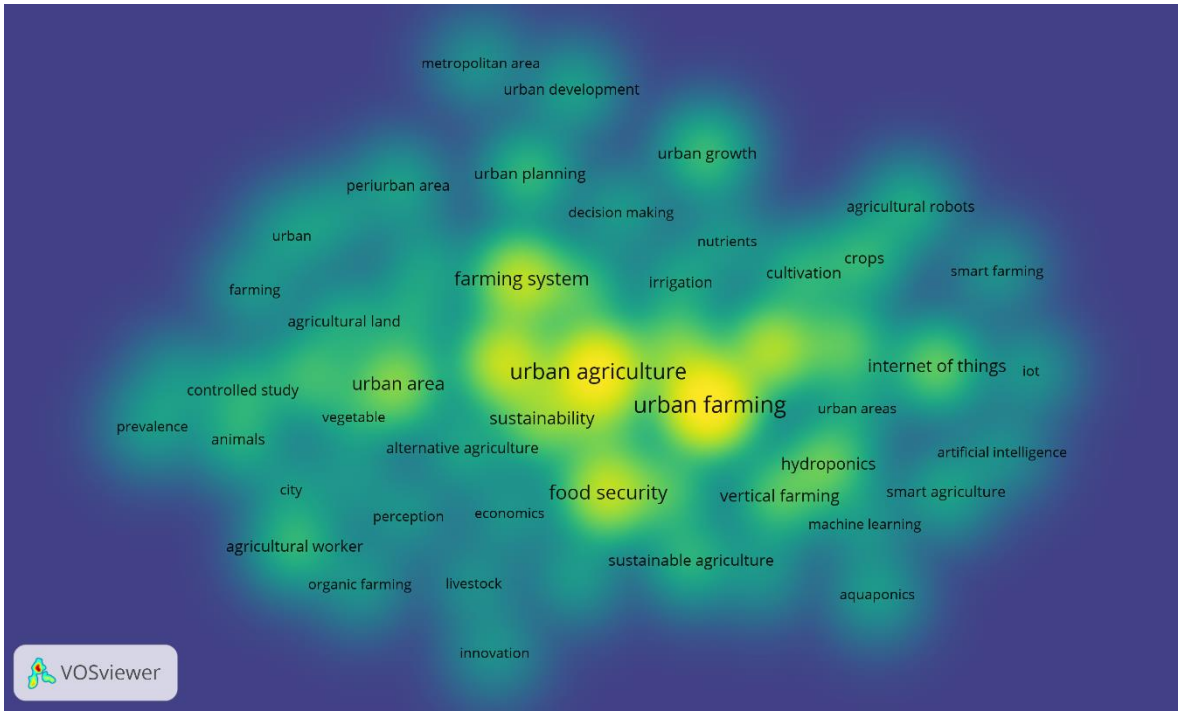

Figure 6. Density Visualization
Source: Data Analysis

Figure 6 illustrates the concentration and intensity of research topics within the urban farming literature. The brightest areas, represented by yellow regions, indicate keywords with the highest occurrence and strongest research attention. The most prominent areas are centered around urban farming, urban agriculture, farming system, sustainability, and food security, demonstrating that these concepts form the core knowledge structure of the field. The strong density around these terms indicates that urban farming research is primarily focused on the role of agriculture in supporting sustainable urban development, improving local food availability, and creating resilient food systems in response to urbanization challenges.

The visual representation also highlights other upcoming themes that have relatively low but increasing density, especially those associated with technological advances. Some examples of these themes include Internet of Things (IoT), artificial intelligence, smart agriculture, vertical farming, hydroponics, aquaponics, and machine learning. These are some examples of new themes that exist alongside the main theme of research. This shows that the researches on urban farms are going beyond the traditional methods of agricultural activities and are moving towards technology-based agricultural production. The combination of themes based on sustainability and technologies suggests that the future research on urban farming will be inclined towards the incorporation of technologies and sustainable methods of food production.

Discussion

The bibliometric study reveals that urban farming has evolved into a research discipline that brings together agricultural science, urban planning, environmental sustainability, and technology innovations. From the analysis of publication trends and keyword networks, one can observe that the notion of urban farming has moved from being traditionally perceived as food cultivation within urban areas to a more sustainability-focused vision. Among early landmark papers are the works emphasizing the multi-functions of peri-urban agriculture in terms of providing ecosystem services, utilizing land resources, and social functions. Gradually, researchers' interests have broadened, moving to the importance of

urban farming in solving global problems of food security, pressure of urbanization, and climate change.

The results also show that technological progress has turned out to be one of the key emerging areas of urban farming studies. The high correlation of urban farming with terms like Internet of Things (IoT), artificial intelligence, smart farming, vertical farming, hydroponics, and machine learning means an increasing number of attempts to boost agricultural efficiency through digitalization. Thus, the results indicate that researchers pay more attention to the ways how the problem of limited space in cities can be overcome using controlled environment agriculture and intelligent agricultural techniques. Technologies such as automatic monitoring, precise cultivation, and decision-making based on collected data can help to enhance productivity and decrease the consumption of resources. But at the same time, the creation of urban agricultural systems with the use of technologies demands taking into account their economic viability and accessibility by the local community.

Besides, the authorship, institutional, and country collaboration trends reveal that the research on urban farming is characterized by a global and interdisciplinary character. This is evidenced by well-developed research networks among the countries such as Indonesia, the USA, China, India, Germany, and the UK, which shows that the issue of urban farming has already become an area of shared research interests. However, at the same time, it can be observed from the collaboration network that knowledge production still remains within several leading countries and institutions, which gives room for further international cooperation and collaboration, especially with developing regions that suffer from food insecurity and sustainability problems.

4. CONCLUSION

This study presents a full bibliometric assessment of the existing literature on urban farming research, analyzing publication patterns, influential papers, collaboration networks, and emerging research themes. The results suggest that urban farming has transformed from the topic of peri-urban agriculture and local food production into a multi-disciplinary subject incorporating the issues of sustainability, food security, urban development, and technological innovation. As shown by the keyword analysis, contemporary researchers pay considerable attention to the use of smart farming practices, which include vertical farming, hydroponics, IoT, artificial intelligence, and other digital technologies aimed at increasing efficiency of the agriculture sector in the urban environment. Moreover, according to the results of the collaboration analysis, research in the area of urban farming has been carried out with extensive international cooperation, though knowledge generation still occurs within the borders of several key nations and organizations. It can be argued that the field of urban farming is of high importance for tackling future challenges connected with urbanization, sustainability, and food security. Future research is required to examine in depth the aspects of combining advanced technologies, circular economy, and policy framework of urban farming systems.

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