

REVIEW

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Mobile technology in agriculture: a bibliometric and science mapping analysis of global research trends and applications

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Abstract

Many farmers encounter three primary obstacles to adopting mobile technology, including digital literacy gaps, unreliable connectivity, and high costs, which affect both remote areas and under connected regions. Additionally, women farmers face specific cultural and gender-related barriers to accessing mobile technology. This study presents a bibliometric and science mapping analysis of global research trends and applications of mobile technology in agriculture between 2018 and 2024. The study found that key research themes include mobile applications, the Internet of Things (IoT), and precision agriculture, reflecting the increasing adoption of advanced technologies in agricultural systems. It also revealed that India, China, and the United States are the most prolific contributors to the publication output. The study also revealed that the most critical solutions for these problems are Public-private partnerships, policy, and international collaboration. This study contributes to the body of literature by providing comprehensive worldwide bibliometric analysis that identifies research gaps and trends in mobile agriculture, as well as the sociocultural factors influencing the adoption of new technologies. Further studies should focus on implementing advanced mobile strategies, as well as connecting them with IoT, blockchain, and artificial intelligence, to address environmental problems and food security challenges cost-effectively. For the promotion of mobile technologies that are sustainable and resilient agricultural systems internationally, research should be conducted using multiple discipline experts to ensure diverse perspectives are considered.

1 Introduction

Mobile technology has advanced considerably, resulting in substantial transformations in agriculture and various other sectors. The utilisation of mobile devices in agriculture has transformed farming by enhancing production through the connection of innovative solutions to conventional agricultural challenges. Mobile technology has enabled farmers to access resources they critically require, like weather predictions, the market price, and advice on farming practices, so they are now better decision-makers [1, 2].



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The adoption of agricultural technology using mobile phones has become more accessible due to the widespread spread of mobile and internet connectivity in developing countries. Mobile phone subscriptions worldwide reached eight billion in 2023, and these subscriptions exceeded 70% in low- and middle-income countries [3]. Smallholder farmers now have mobile tools that help them gain timely information and boost their productivity, and enter new value chains which were once beyond their reach [4, 5].

The application of mobile technology in agriculture includes services involving agricultural advisories and digital market linkages systems. The services mFarm in Kenya and e-Krishi in India give farmers access to up-to-date market data, which enables them to make smart decisions regarding prices and delivery options [6]. Additionally, mobile technology has enabled precision agriculture processes by delivering data-oriented agricultural knowledge about soil health, pest management and irrigation techniques to farmers [7].

This study makes several significant contributions to the field of mobile agriculture research. First, it bridges the gap between climate-smart agriculture and mobile technology applications, thereby establishing a new multifaceted approach. Second, by assessing the revolutionary potential of next-generation technologies, such as blockchain, AI, and IoT, in tackling productivity issues, the study pioneers new territory. Finally, the study introduces a novel approach to methodology by combining bibliometric mapping with in-depth thematic analysis, providing a more sophisticated and evidence-based understanding of global patterns than earlier single-method approaches.

Many farmers encounter three main obstacles to mobile technology adoption due to digital literacy gaps and unreliable connectivity, along with high costs that affect both remote areas and unconnected region [8, 9]. And women farmers face specific cultural and gender-related barriers to mobile technology access [10]. Research studies of mobile technology in agriculture have strengthened throughout time by examining various elements such as technology acceptance, impact assessment and policy analysis. The adoption of mobile applications for farmers depends on three key factors, including perceived ease of use, perceived usefulness and trust, according to studies by [11, 12]. Additionally, mobile technology adoption gets significant support from government policies, which work together with public–private partnerships [13–15]. The research shows a pattern of investigative focus on Sub-Saharan Africa and South Asian regions because these areas have significant agricultural economic power [16, 17]. However, there is a growing need for more inclusive research that encompasses diverse agro-ecological zones and farming systems. This would provide a holistic understanding of the global impact of mobile technology in agriculture.

Furthermore, the agricultural sector faces various new risks and opportunities through the advancements in artificial intelligence (AI), blockchain and Internet of Things (IoT) within the technology sector. The developed technologies promise better and faster agricultural techniques and solutions for environmental preservation, together with resource management capability [18–20].

Although existing studies have examined the role of mobile technology in agriculture, most have been region-specific, focusing primarily on Sub-Saharan Africa and South Asia, and have been limited in scope, often addressing only aspects such as market access or advisory services. There remains a lack of bibliometric and science mapping analyses that synthesise global mobile agriculture research trends, particularly those that identify

knowledge gaps across diverse farming systems and regions, and assess the integration of emerging technologies, such as AI, IoT, and blockchain, into mobile-based agricultural solutions. Similarly, while a few studies [21, 22] have analysed the environmental impacts of CO₂ emissions, their direct effects on agricultural productivity, especially in conjunction with mobile technology adoption, remain underexplored. This gap hinders policy efforts to balance productivity gains with climate-smart practices. This study aims to fill a critical knowledge gap by examining the existing literature on mobile technology in the agricultural sector. The study's specific objectives are to synthesize existing literature on mobile technology in agriculture to identify key trends, knowledge gaps, and future directions. Specifically, this study aims to provide a comprehensive bibliometric and science mapping analysis of global research on mobile technology in agriculture by examining publication trends, influential contributors, collaboration networks, thematic patterns, and research gaps to inform future scholarly and practical advancements in the field. To guide the analysis, the study is framed by the following research questions:

1. What are the key research themes in mobile technology for agriculture?
2. How has the field evolved from 2018 to 2024?
3. Who are the most influential contributors and institutions in this area of research?
4. What collaboration patterns and co-authorship networks exist?
5. What gaps and emerging topics can inform future research?

The main results of this study indicate that gender inequalities and cultural obstacles are preventing the farmers from accessing mobile technology freely. The study also revealed that the most critical solutions for these problems are Public–private partnerships, policy, and international collaboration. This study contributes to the body of literature by providing comprehensive worldwide bibliometric analysis that identifies research gaps and trends in mobile agriculture, as well as the sociocultural factors influencing the adoption of new technologies. The study offers valuable insights for researchers, organizations, and policymakers seeking to support inclusive and technologically driven agricultural transformation, highlighting the connection between gender, culture, and technical access.

This study integrates thematic evolution analysis to reveal how topics such as gender equity, digital inclusion, and sustainable governance have emerged alongside technological innovation. This approach offers novel insights into the intersection of digital agriculture with socio-technical systems and responsible innovation frameworks.

By synthesizing these multifaceted dimensions, our study provides a foundational knowledge base that not only informs academic inquiry but also supports evidence-based policymaking. The findings highlight critical knowledge gaps and suggest pathways for future interdisciplinary research that connects mobile technology with cutting-edge digital platforms like IoT, blockchain, and artificial intelligence to address pressing agricultural challenges and Sustainable Development Goals (SDGs).

2 Methods

2.1 Bibliometric research approach

Through bibliometric research, a distinctive viewpoint can be derived from a reasonably thorough analysis. For quantitative scientometrics and informetrics, the R package's bibliometrics utility is designed [23]. In order to obtain information from the repository,

bibliometric technologies further enable the classification and examination of substantial volumes of historical data gathered from studies carried out over a specific period. In contrast to systematic literature reviews, which usually rely on qualitative techniques and may be tainted by interpretation bias from scholars with different academic backgrounds, bibliometric analysis, and science mapping analysis rely on quantitative techniques and can, therefore, avoid or mitigate the bias [24, 25].

Based on bibliometric analysis, this study examined current trends in Mobile Technology in Agriculture research. Bibliometric analysis is a repeatable, transparent, objective, and rigorous quantitative statistical assessment of publications. Of all the bibliometric techniques, science mapping and descriptive analysis are the most important. Examining several publications and journal indices is part of the descriptive analysis, which helps determine how influential writers and sources are at publishing their work. Conversely, science mapping reveals the theoretical frameworks of specific fields of study, usually through keyword and citation analyses that pinpoint popular subjects, emerging themes, and areas of research interest.

2.2 Data source and database justification

Several databases are available for importing bibliographic information, including Scopus, Web of Science (WoS), Dimensions, Lens, Cochrane Library, and PubMed. Each of these databases has its features and purposes. The most popular literature databases for practically all disciplines are Web of Science and Scopus [26, 27]. The study used the Scopus database to search for documents, as it contains a large number of publications and rich citation data [28]. Additionally, Scopus provides broad multidisciplinary coverage and up-to-date indexing, making it one of the most comprehensive and reliable sources for bibliometric analysis in the field. Scholars can examine and assess publications, patents, technical reports, and agricultural policy documents using the integrated Scopus database.

2.3 Search strategy, keywords, and selection criteria

The search string used in the Scopus database included the terms: “*mobile technology*”, *agriculture*, *bibliometric analysis*, *IoT*, and *precision agriculture*. This query was applied to the article title, abstract, and keywords fields [29, 30]. The inclusion criteria were: (i) publications between 2018 and 2024, (ii) peer-reviewed journal articles, conference papers, and reviews, and (iii) English-language documents. The exclusion criteria involved: (i) non-English articles, (ii) editorial materials, letters, and notes, and (iii) duplicate entries or documents lacking essential bibliographic metadata.

2.4 Data selection and analysis tools

From 2018 to December 23, 2024, a total of 2154 research documents were retrieved from the Scopus database. After applying the predefined inclusion and exclusion criteria, all 2,058 documents were retained for bibliometric analysis. As illustrated in Fig. 1, the PRISMA flow diagram depicts the identification, screening, eligibility, and inclusion stages of the document selection process. The entire collection of bibliographic information was obtained from the Scopus database in CSV format. First, R Studio was loaded, and the Bibliometrix R package was installed. Typing `biblioshiny()` on the R terminal opened the Biblioshiny program. A web application called Biblioshiny gives

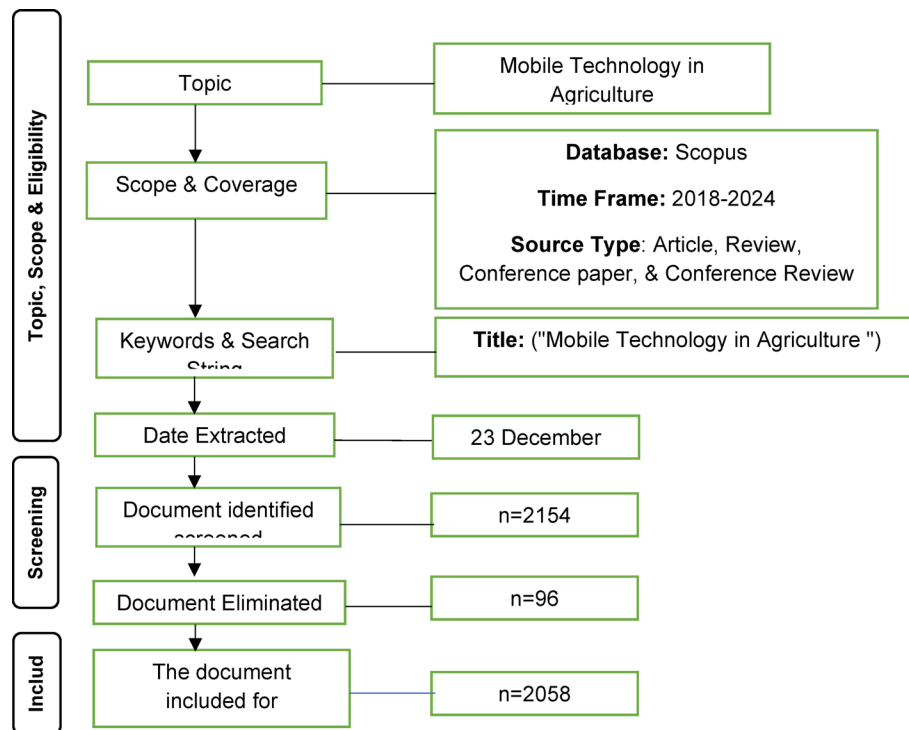


Fig. 1 The PRISMA flow diagram of the document selection process

non-programmers access to R's Bibliometrix package. Researchers can perform a comprehensive bibliometric analysis with the help of Bibliometrix's many tools [31].

To simplify the complex keyword network linkages, the frequency of the concurrent occurrence of keywords in two scientific papers was found using data mining in bibliometrics using the statistical software package Biblioshiny. One file was uploaded to the Biblioshiny interface in Excel format (.csv). By the study's goals, Excel files (.csv) and portable network graphics files (.png) were also downloaded and used for data analysis. We used VOSviewer to provide detailed information on mobile technology in agriculture research to extract other trends. The international publication map was examined using VOSviewer, a program designed to produce and display bibliometrics maps. Quoting an article or issue allows users to use a text-mining algorithm to build and display a network or relationship. With various display settings and functions, such as scrolling, zooming, and searching, it can map longer articles and publications. With VOSviewer, individual data can be shown and depicted on the Bibliometrics graphic map. A large bibliometric map makes it simple for researchers to understand a relationship, and this software has been used in bibliometric analysis in many other studies [27, 28].

3 Results

3.1 Descriptive analysis

Table 1 provides a comprehensive overview of the research landscape on mobile technology in agriculture from 2018 to 2024, highlighting significant growth and scholarly collaboration. With 2058 documents published across 1099 sources, the field exhibits a notable annual growth rate of 15.68%, emphasising its increasing prominence in academia. The average document age of 2.48 years reflects the contemporary and dynamic nature of this research domain. The average citation rate of 11.37 per document

Table 1 Research landscape overview (2018–2024)

Description	Results
Main information about data	
Timespan	2018:2024
Sources (Journals, Books, etc.)	1099
Documents	2058
Annual growth rate %	15.68
Document average age	2.48
Average citations per doc	11.37
References	58,462
Document contents	
Keywords Plus (ID)	9694
Author's Keywords (DE)	5104
Authors	
Authors	7727
Authors of single-authored docs	68
Authors collaboration	
Single-authored docs	74
Co-authors per doc	4.33
International co-authorships %	17.59
Document types	
Article	899
Conference paper	1045
Conference review	64
Review	50

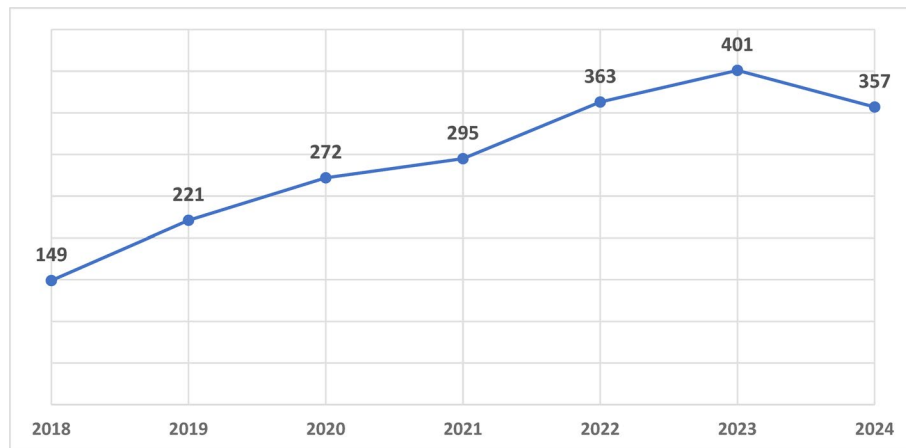
underscores the impactful nature of these studies within the academic community. Authorship analysis reveals a high degree of collaboration, with an average of 4.33 co-authors per document and 17.59% of publications resulting from international partnerships, although single-authored works are rare (74 papers). The diversity of research themes is evident in the breadth of Keywords Plus (9694) and Authors' Keywords (5104). The majority of the publications are conference papers (1045) and journal articles (899), highlighting the role of both academic conferences and peer-reviewed journals in disseminating findings. The substantial reference base of 58,462 citations further demonstrates the scholarly rigour and depth of the field.

3.2 Yearly publication trend

The yearly publication trend on mobile technology in agriculture from 2018 to 2024 demonstrates a consistent upward trajectory, signalling growing scholarly engagement with this transformative field. Starting with 149 publications in 2018, research output increased steadily, peaking at 401 publications in 2023, before a slight dip to 357 in 2024 (Fig. 2). This trend reflects heightened academic and practical interest driven by rapid technological innovations and the urgent need to address global agricultural challenges such as food security, climate change, and sustainable resource management. The modest decline in 2024 may suggest a maturation of the field or diversification into more specialized subtopics, indicating an evolving research landscape.

3.3 Most productive authors

Table 2 highlights the most productive authors in the field of mobile technology in agriculture, reflecting both their research output and scholarly impact. Wang emerges as the

**Fig. 2** Yearly publication trend**Table 2** Product authors

Author	h_index	g_index	m_index	TC	NP	PY_start
Wang J	8	16	1.6	308	16	2020
Barman U	6	9	1	213	9	2019
Birner R	6	6	0.857	153	6	2018
Daum T	6	6	0.857	153	6	2018
Li Y	6	12	1.5	159	13	2021
Zhang Y	6	7	1.2	264	7	2020
Confalonieri R	5	6	0.714	121	6	2018
Ma W	5	6	0.714	358	6	2018
Paleari L	5	6	0.714	121	6	2018
Wang L	5	10	1	184	10	2020

leading contributor, with 16 publications since 2020, supported by the highest h-index (8), g-index (16), and an impressive m-index of 1.6, indicating consistent and influential productivity. Li Y follows closely with 13 publications since 2021 and leads in g-index (12), along with a strong m-index of 1.5, underscoring rapid research momentum. Zhang Y and Wang L also show notable contributions Zhang Y with a total of 264 citations across 7 papers and Wang L with 10 publications and an m-index of 1. Other impactful authors such as Barman U, Birner R, and Daum T have sustained steady outputs since 2018–2019, each attaining h-indices of 6 and significant citation counts (153–213), reflecting their continued relevance in the field. Collectively, these scholars demonstrate the dynamic and growing body of research driving innovation in mobile technology applications within agricultural contexts.

3.4 Highly cited papers

Table 3 highlights the most highly cited publications in mobile technology and agriculture, illustrating their substantial influence on both research and practice. The leading paper, “A Survey on the Role of IoT in Agriculture for the Implementation of Smart Farming” (580 citations), has been pivotal in establishing the foundation for IoT-driven smart farming. Likewise, “IoT and Agriculture Data Analysis for Smart Farm” (578 citations) reinforces the importance of data analytics in optimising farm operations. The prominence of “Unmanned Aerial Vehicles in Smart Agriculture” (370 citations) signals the

Table 3 Most highly cited papers

Titles	Total citations	TC per year
A Survey on the Role of IoT in Agriculture for the Implementation of Smart Farming	580	96.67
IoT and agriculture data analysis for smart farm	578	96.33
An explainable deep machine vision framework for plant stress phenotyping	393	56.14
Unmanned aerial vehicles in smart agriculture: Applications, requirements, and challenges	370	92.50
Deep convolutional neural networks for mobile capture device-based crop disease classification in the wild	367	61.17
Internet of Things in arable farming: Implementation, applications, challenges and potential	253	50.60
A megatrend challenging analytical chemistry: biosensor and chemosensor concepts ready for the internet of things	221	36.83
Food access in crisis: Food security and COVID-19	217	54.25
Realizing the potential of digital development: The case of agricultural advice	180	30.00
Custom-made 3D-printed face masks in case of pandemic crisis situations with a lack of commercially available FFP2/3 masks	169	33.80

Table 4 Most productive source titles

Source	h_index	g_index	m_index	TC	NP	PY_start
Computers and Electronics in Agriculture	22	42	3.143	2182	42	2018
Sensors (Switzerland)	12	12	1.714	441	12	2018
IEEE Access	11	18	1.833	1092	18	2019
Agronomy	10	14	2	289	14	2020
Sensors	10	17	2.5	302	21	2021
Agriculture (Switzerland)	9	17	1.8	307	19	2020
Sustainability (Switzerland)	8	11	1.143	135	13	2018
Advances in Intelligent Systems and Computing	7	12	1	178	32	2018
Applied Sciences (Switzerland)	7	9	1.4	225	9	2020
International Journal of Advanced Computer Science and Applications	7	16	1	278	16	2018

growing role of UAVs in enabling precision agriculture. AI-focused studies such as “*An Explainable Deep Machine Vision Framework for Plant Stress Phenotyping*” and “*Deep Convolutional Neural Networks for Mobile Capture Device-Based Crop Disease Classification*” reflect a shift toward intelligent systems for plant health monitoring. Additionally, papers like “*Internet of Things in Arable Farming*” and “*Food Access in Crisis: Food Security and COVID-19*” broaden the discourse by linking digital agriculture to systemic challenges and global resilience. Collectively, these works map the evolving technological landscape and its practical relevance to agricultural development and digital transformation.

3.5 Most productive source titles

Table 4 highlights the most productive sources in the field of mobile technology in agriculture, with “Computers and Electronics in Agriculture” emerging as the leading journal. It exhibits the highest h-index (22), which quantifies the journal’s ability to produce 22 highly-cited articles, reflecting its consistent research quality and impact [32]. Its g-index (42) highlights broader citation success, measuring the cumulative citation strength across its most impactful articles [33]. Furthermore, the m-index’s value (3.143) adjusts the h-index calculation through time parameters to demonstrate continuing influence according to [34]. The journals “Sensors (Switzerland)” together with “IEEE

Access” achieve h-indices of 12 and 11, which demonstrates their extensive influence in sensor technology development and interdisciplinary applications research. The journals *Agronomy* and *Sensors* demonstrate rapid research progress through their respective m-indices of 2.0 and 2.5, which signal vigorous research intensity during short periods. The agricultural context of sustainability and intelligent systems appears throughout articles published in “Sustainability (Switzerland)” alongside “Advances in Intelligent Systems and Computing.” Research and innovation in mobile agricultural technology are supported by various sources, which offer numerous coordinating platforms.

3.6 Most productive countries

As depicted in Table 5, the visualization highlights the most prolific countries contributing to research on mobile technology in agriculture. India leads the field with the highest number of articles (304, 14.8%), showcasing a dominant role in research productivity. Most of India’s publications are single-country publications (SCP: 285), with a modest share of multi-country collaborations (MCP: 19, 6.3%), indicating a focus on localised research. China follows with 149 articles (7.2%), excelling in multi-country collaborations (MCP: 35, 23.5%), highlighting its global engagement. The USA, with 88 articles (4.3%), demonstrates the highest percentage of MCP (28.4%), reflecting its strong international collaboration. Other notable contributors include Indonesia (63 articles, 3.1%), Malaysia (49 articles, 2.4%), and Italy (39 articles, 1.9%), with varying degrees of MCP, emphasizing both regional and international research partnerships. Germany, with 31 articles (1.5%), exhibits the highest percentage of MCP (41.9%), signifying its extensive collaborative networks. The network visualization further illustrates the interconnectedness of countries like India, China, and the USA, reinforcing their central role in driving global research on mobile technology in agriculture.

3.7 Top frequent authors’ keywords

Table 6 and Fig. 3 highlight the most frequently used keywords in research on mobile technology in agriculture, revealing key themes and trends. The keyword “agriculture” appears 504 times, signifying its primary focus. Other prominent keywords include “Internet of Things” (439 occurrences) and “mobile applications” (354 occurrences), highlighting the integration of advanced technologies. “Crops” (270 occurrences) and “smartphones” (265 occurrences) emphasize the practical use of these technologies. Emerging technologies such as “agricultural robots” (241 occurrences) and “deep learning” (239 occurrences) underscore the increasing role of automation and AI in farming.

Table 5 Top research countries

Country	Articles	Articles %	SCP	MCP	MCP %
India	304	14.8	285	19	6.3
China	149	7.2	114	35	23.5
USA	88	4.3	63	25	28.4
Indonesia	63	3.1	60	3	4.8
Malaysia	49	2.4	41	8	16.3
Italy	39	1.9	32	7	17.9
Thailand	39	1.9	35	4	10.3
Brazil	33	1.6	26	7	21.2
Germany	31	1.5	18	13	41.9
Australia	23	1.1	16	7	30.4

Table 6 top frequent authors' keywords

Words	Occurrences
Agriculture	504
Internet of things	439
Mobile applications	354
Crops	270
Smartphones	265
Agricultural robots	241
Deep learning	239
Precision agriculture	176
Mobile computing	164
Soil moisture	159



Fig. 3 Most Frequent Keywords

Additionally, “precision agriculture” (176 occurrences) and “mobile computing” (164 occurrences) indicate a focus on resource optimization. Lastly, “soil moisture” (159 occurrences) points to the significance of environmental monitoring. Overall, these keywords reflect a field that merges traditional agriculture with innovative technologies.

3.8 Thematic evaluation

Thematic evaluations provide researchers with a deep understanding of changing trends and conceptual links within specific research fields, such as agriculture and technology. The application of big data, IoT, and automation in agriculture receives extensive analysis because these technologies work together to boost sustainability and productivity [35, 36]. Figure 4 illustrates how mobile technology and agriculture research subjects have shifted their focus between 2018 and 2024. Academic topics regarding “Internet of Things,” “farming systems,” and “monitoring” during 2018 developed into specific and broader topics about “deep learning,” “smartphones,” and “precision agriculture” from 2019 through 2024. Deep learning technology now integrates with agricultural practices due to this theme-to-theme alignment. The global spread of technology tools to farmers becomes possible because the “smartphone” keyword reaches more people. Through thematic development, the focus shifted from basic technologies to goal-oriented

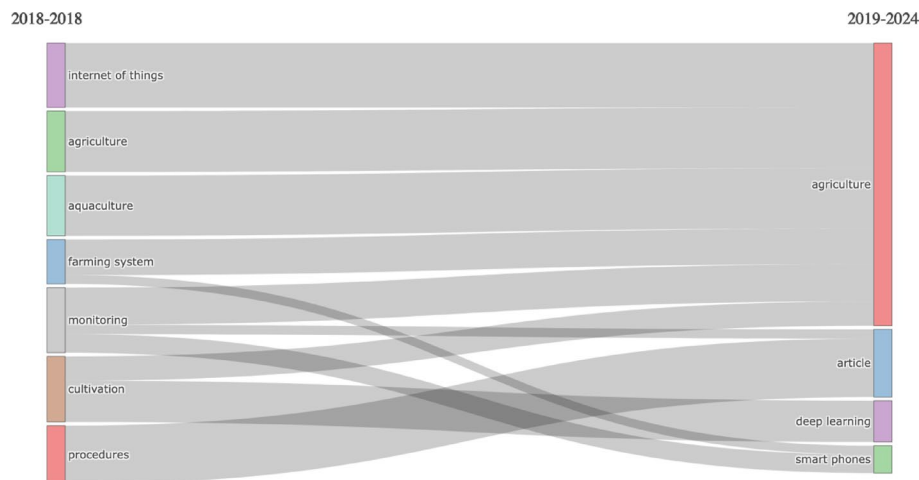


Fig. 4 Thematic evaluations

applications that align with agriculture-centred global initiatives aimed at increasing efficiency and sustainability.

3.8.1 Thematic map

Thematic maps are tools for visualising the relationships between different research topics based on their centrality (relevance) and density (development). Centrality indicates the relevance of a theme to the overall field, while density reflects its level of internal development and specialisation. Recent studies by [35, 36] emphasize the use of thematic mapping to identify strategic research directions in agriculture and technology.

In this thematic map, key research themes are categorised into four quadrants: motor themes (high centrality and density), basic themes (high centrality but low density), emerging or declining themes (low centrality and density), and niche themes (low centrality but high density). The “Internet of Things,” “mobile applications,” and “crops” occupy the motor themes quadrant, indicating their pivotal role as well-developed and highly relevant topics in the field of mobile technology in agriculture. The dominance of IoT-related themes underscores the centrality of sensor networks, real-time data acquisition, and smart infrastructure in contemporary agricultural systems. This also reflects global research orientation toward precision agriculture and automation, emphasizing efficiency, responsiveness, and data-driven decision-making in farming practices. Basic themes, such as “agriculture” and “smartphones,” represent foundational research areas that are central to the domain but less internally developed. Additionally, smartphone-based agriculture reflects increasing accessibility and deployment of mobile solutions for real-time farming assistance, especially in low-resource settings. This indicates a strong trend toward digitisation and democratisation of agricultural tools. Meanwhile, “deep learning” and “convolutional neural networks” fall into the emerging themes quadrant, signifying their growing importance and potential for future development. This theme indicates a clear shift toward the integration of advanced, data-driven technologies in agriculture. The prominence of deep learning suggests growing interest in predictive analytics, automated decision-making, and image-based crops or soil assessments. Niche themes, such as “human” and “animals,” are highly specialised but less relevant to the broader context of mobile agriculture technology. Their presence may point to

interdisciplinary applications (e.g., veterinary tech, labour monitoring), but they remain peripheral to core developments. Figure 5 presents a map that reflects the prioritisation of technological integration in agriculture while highlighting emerging technologies, such as AI and deep learning, as growing areas of interest and investment.

3.9 Factorial map

Through multidimensional scaling visualization, the factorial map shows variable relationships based on their element or dimensional manifestation values. The factor maps enable researchers to conduct bibliometric and conceptual structure analyses by showing how keywords or topics cluster together and connect in research domains. A factorial map reveals concealed patterns, thematic clusters, and conceptual intersections by charting data across dimensions, so providing significant insights into the foundational structure of a research domain [35].

Figure 6 presents the factorial map of mobile technology in agriculture positions in essential terms along two axes, which are Dim one and Dim 2. Keywords like “Internet of Things,” “irrigation systems,” and “soil moisture” cluster towards the upper right, emphasising their interconnected roles in resource management and precision agriculture. The cluster of “Convolutional neural networks,” “deep learning,” and “plant disease” appears distinctively in the left portion due to their role in complex AI-based crop inspection and illness detection systems. Three fundamental concepts of “agriculture,” “smartphones,” and “mobile phones” form the base of numerous subdomains where they unite advanced technology with agricultural application methods. This wide-scale map structure demonstrates that the field research area includes basic technological solutions for irrigation along with advanced diagnostic capabilities supported by machine learning methods. Research benefits from visual maps because they help detect upcoming developments which define new academic directions.

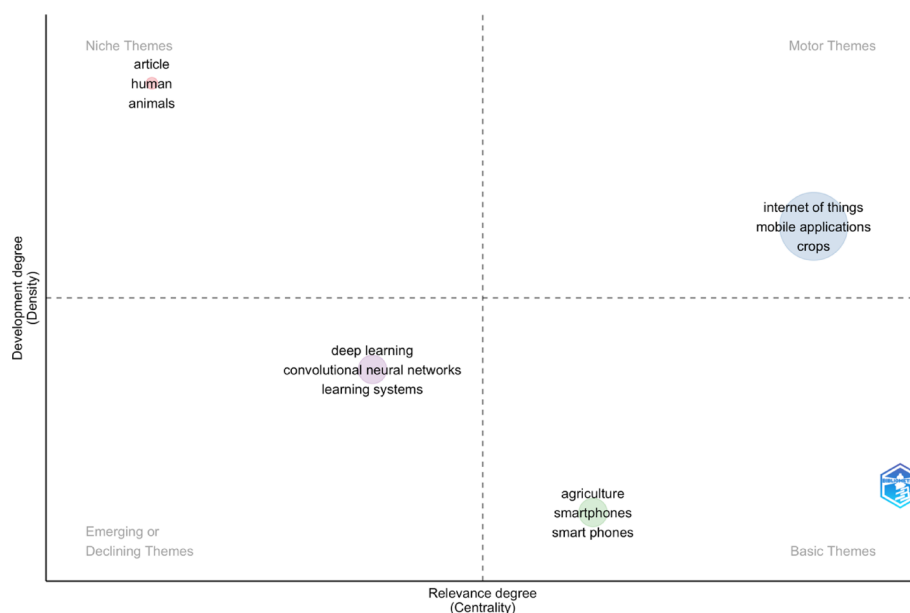


Fig. 5 Thematic maps

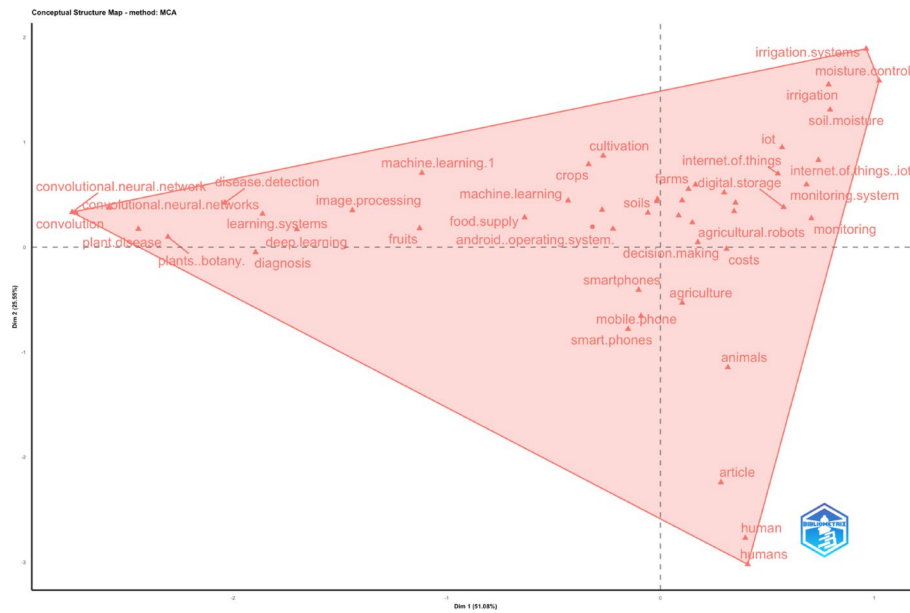


Fig. 6 The factorial map

3.10 Co-citation cited authors

The bibliometric method known as co-citation analysis evaluates research field intellectual structure through the identification of citation pair groups that occur repeatedly. Through this technique, researchers find the conceptual relationships between studies within a research domain, together with associated themes that demonstrate scientific collaboration and identify key publications [37, 38]. It is particularly useful for mapping the evolution of knowledge and identifying emerging trends [39].

Figure 7 illustrates the co-citation network, showing the author's node size based on their co-authorship frequency to demonstrate their impact on mobile technology research in agriculture. Wang J., Zhang Y., and Li Y. form the core of the network due to their essential contributions. The network displays thematic clusters using color coding, while cluster density reflects the level of co-dependence between precision agriculture systems, machine learning applications, and IoT-based solutions. The visual representation demonstrates how core authors, along with thematic research groups, contribute to the modern research development of artificial intelligence applications in agriculture.

4 Discussion

Many farmers encounter three main obstacles to mobile technology adoption due to digital literacy gaps and unreliable connectivity along with high costs that affect both remote areas and unconnected region and women farmers face specific cultural and gender-related barriers to mobile technology access. In this research, a total of 2154 documents related to mobile technology in agriculture were initially retrieved, of which 2058 met the inclusion criteria and served as the foundation for the scientific mapping of current trends from 2018 to 2024. A bibliometric mapping analysis of mobile technology in agriculture was performed through Vosviewer software, which provided subject topics measurements by using thematic evolution trend analysis through R software. Research trends from across the globe about mobile technology in agriculture demonstrate an accelerating field that has fundamentally transformed conventional agricultural

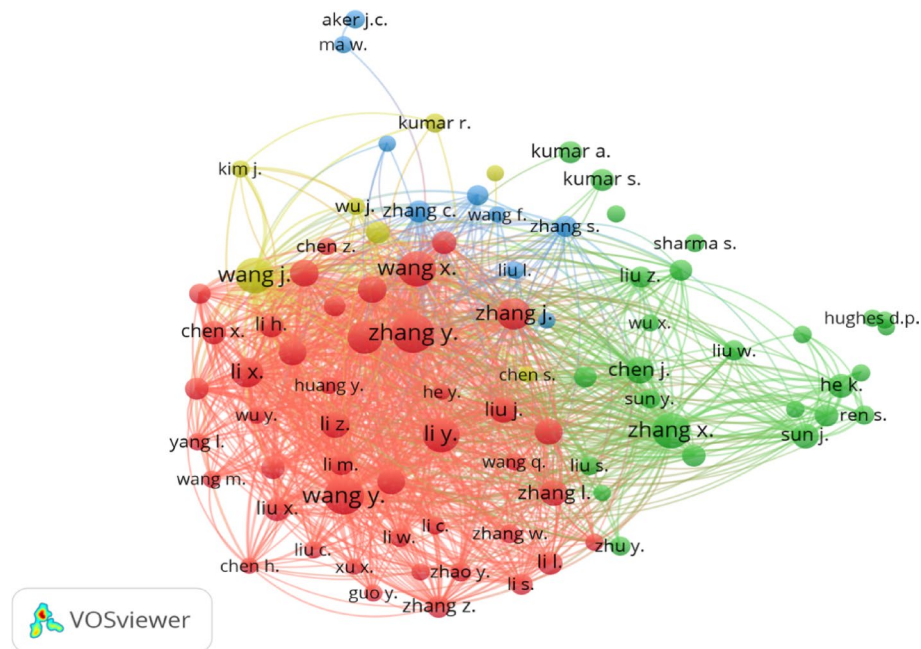


Fig. 7 The co-citation network

operations. Mobile technology has been instrumental in improving agricultural production and productivity, together with operational efficiency and sustainability in agriculture.

The integration of mobile devices, IoT, and AI technologies, alongside other technological platforms, has provided farmers with instant data, enhancing resource optimisation and decision-making capabilities over the last decade. Scholarly interest in this domain has grown steadily, as shown by the increasing number of publications from 1,099 diverse sources that reached 2,058 documents annually at a rate of 15.68%

Among the leading nations in scholarly research, India receives the first position, followed by China and the United States of America. Indian research prioritises domestic research projects, but Chinese and American research institutions actively seek international partnerships, which demonstrates the value of international collaborations for innovation.

In conjunction with these thematic and factorial maps, it is apparent that key research areas, such as IoT, precision agriculture, and artificial intelligence, are interconnected, illustrating the intellectual structure of the field. The analysis showed it is important to develop inclusive measures that will bring the benefits of advanced agriculture to all farmers. The future of mobile technology in agriculture lies in integrating emerging technologies like blockchain, artificial intelligence, and IoT to address global challenges such as climate change, food security, and resource scarcity. The study also suggests that future research should focus on linking the digital divide, especially in developing regions, and exploring how mobile technology can empower smallholder farmers. Additionally, Inclusive and collaborative research should be prioritised to ensure that mobile technology advances agricultural productivity while promoting sustainability and resilience in farming systems worldwide.

The study revealed that the most critical solutions for these problems are Public–private partnerships, policy, and international collaboration. This study contributes to the

body of literature by providing a comprehensive worldwide bibliometric analysis that identifies research gaps and trends in mobile agriculture, as well as the sociocultural factors influencing the adoption of new technologies. Among the leading contributors, India dominates in publication output, followed by China and the United States. Notably, Indian research is largely domestically focused, while China and the U.S. demonstrate stronger international collaboration. This difference may reflect underlying innovation systems and funding structures. India's surge could be tied to national digital agriculture initiatives. In contrast, U.S. and Chinese patterns may align with global anticipatory governance approaches that prioritise cross-border knowledge sharing and technology diffusion. Factorial and thematic maps show that key research domains, including AI, precision agriculture, and IoT, are tightly interconnected, suggesting a coherent intellectual structure within the field. However, our analysis also shows that sociocultural inequalities, particularly gender norms and cultural expectations, contribute to uneven access to these technologies. This points to the need for inclusive digital innovation systems that address both infrastructural and societal constraints.

Furthermore, the findings of this study align with technology diffusion theory, which explains how innovations spread across populations over time and are influenced by factors such as communication channels, social systems, and adopter characteristics.

5 Conclusion

The study conducts comprehensive bibliometric and science mapping analysis of mobile technology use in agriculture from 2018 to 2024, examining global research trends and applications. The study revealed that the most critical solutions for these problems are Public–private partnerships, policy, and international collaboration. This mapping exercise enhances our understanding of the evolving structure of agricultural knowledge production. It highlights the extent to which current research is prepared to address pressing global challenges such as equity, sustainability, and governance in digital agriculture. This study contributes to the body of literature by providing comprehensive worldwide bibliometric analysis that identifies research gaps and trends in mobile agriculture, as well as the sociocultural factors influencing the adoption of new technologies. Further studies should focus on implementing advanced mobile strategies, as well as connecting them with IoT, blockchain, and artificial intelligence, to address environmental problems and food security challenges cost-effectively. For the promotion of mobile technologies that are sustainable and resilient agricultural systems internationally, research should be conducted using multiple discipline experts to ensure diverse perspectives are considered. This study highlights the need for targeted actions to enhance the adoption of mobile technology in agriculture. The findings of this study have several implications for policymakers, practitioners, and researchers working in digital agriculture: first, Research on mobile agricultural technology must explicitly support SDGs related to no poverty (SDG 1), zero hunger (SDG 2), gender equality (SDG 5), and industry, innovation, and infrastructure (SDG 9). Policies should promote responsible innovation frameworks that address not only productivity but also inclusiveness and sustainability. Second, Governments and development agencies should support the adaptation of mobile technologies to local contexts. This includes customising user interfaces for local languages, enhancing rural connectivity, and promoting user-friendly applications. Finally, Effective policy must integrate social inclusion with technological

deployment. Gender-sensitive planning, investment in infrastructure, and the participation of rural stakeholders in technology design are critical to overcoming the digital divide. Among the recommendations, the study recommends implementing targeted educational interventions, including community-based digital literacy programs and enhanced agricultural extension services tailored to the specific needs of farmers. To address gender disparities, policies should foster inclusive mobile innovation ecosystems by promoting women-focused training, ensuring equitable access to mobile resources, and supporting gender-sensitive infrastructure development. These strategic measures are designed to directly tackle the identified socio-ethical challenges, thereby ensuring that interventions are both practical and effective. The study is limited by the lack of empirical testing of mobile technology integration with IoT, blockchain, and AI, and does not address infrastructure or user challenges. Further studies should focus on implementing advanced mobile strategies, as well as connecting them with IoT, blockchain, and artificial intelligence, to address environmental problems and food security challenges cost-effectively. The study also used only the Scopus database, possibly missing relevant research in other databases like Web of Science and IEEE Xplore. Future research should include these to provide a more comprehensive review. Finally, the study includes only English-language publications, potentially excluding valuable non-English literature, which may affect the global representativeness of the findings. Future research should address these limitations by including multiple databases and broadening language inclusion criteria.

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Author contributions

Husein Osman Abdullahi drafted and revised the manuscript, including the introduction, literature review, methodology, data collection, analysis, and discussion. Professor Murni Mahmud provided overall guidance, contributed to the research methodology and bibliometric analysis, and ensured academic rigor. Dr. Elin Eliana Abdul Rahim refined the theoretical framework, structured the literature review, and provided critical feedback on the discussion and conclusion.

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Data availability

The data supporting the findings of this study are available upon request from the corresponding author.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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