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DIGITAL LITERACY AND TECHNOLOGY ADOPTION IN AGRICULTURE: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT
Agriculture is undergoing rapid transformation with the integration of digital technologies such as artificial intelligence, Internet of Things, and precision farming; however, their adoption remains uneven, particularly among smallholder farmers in developing regions. This study aims to systematically review the existing literature on digital literacy and technology adoption in agriculture, with a focus on identifying key determinants, challenges, and emerging research trends. A systematic literature review (SLR) approach was employed using the PRISMA framework, and relevant studies were retrieved from the Scopus database. An initial set of 584 articles was screened based on predefined inclusion and exclusion criteria, resulting in the final selection of 43 peer-reviewed studies for analysis. The findings reveal that digital literacy plays a critical role in influencing farmers' adoption behavior, acting as a bridge between technological availability and effective utilization. Bibliometric analysis indicates a growing but clustered research landscape, with dominant contributions from countries such as India and strong thematic emphasis on ICT, digital agriculture, financial inclusion, and sustainable development. Despite the potential benefits of digital technologies in enhancing productivity, efficiency, and resilience, several barriers persist, including low digital skills, inadequate infrastructure, high costs, and institutional limitations. Additionally, the presence of a digital divide continues to hinder inclusive agricultural development. The study highlights the need for integrated policy interventions, capacity-building initiatives, and improved digital infrastructure to promote equitable technology adoption. Overall, aligning digital innovation with human capabilities is essential for achieving sustainable and inclusive agricultural transformation

KEYWORDS: Digital Literacy; Technology Adoption; Agriculture; Digital Agriculture; Farmers 'Adoption Behavior; ICT in Agriculture

1. INTRODUCTION

Agriculture remains a cornerstone of economic development, food security, and rural livelihoods, particularly in developing countries such as India. However, the sector is increasingly confronted with multiple challenges, including climate variability, natural resource degradation, labor shortages, and the growing demand for enhanced productivity and sustainability. Traditional farming practices alone are often insufficient to address these emerging concerns, thereby necessitating the integration of advanced digital technologies into agricultural systems (3).

In recent years, the concept of digital agriculture encompassing technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), precision farming, and data-driven decision-making has gained significant attention. These technologies enable farmers to optimize resource utilization, improve crop productivity, and enhance environmental sustainability. For instance, AI-driven systems facilitate real-time monitoring, predictive analytics, and efficient farm management, contributing to increased agricultural efficiency and resilience (3). Similarly, IoT-based smart irrigation systems have demonstrated considerable potential in reducing water wastage and improving resource management through automated and data-driven approaches (1).

Despite these advancements, the adoption of digital technologies in agriculture remains uneven and limited, particularly among smallholder farmers. Several studies highlight that inadequate infrastructure, high implementation costs, limited access to digital tools, and lack of technical knowledge act as major barriers to adoption. Among these factors, digital literacy plays a crucial role in determining farmers' ability to understand, access, and effectively utilize modern technologies. Low levels of digital literacy restrict farmers' engagement with innovative tools, thereby widening the digital divide in rural areas (5).

Furthermore, technology adoption in agriculture is influenced by a complex interplay of socio-economic, institutional, and behavioral factors. The Technology Acceptance Model (TAM) suggests that perceived usefulness and perceived ease of use significantly influence farmers' willingness to adopt new technologies. However, beyond these cognitive aspects, contextual factors such as policy support, extension services, and socio-cultural conditions also shape adoption decisions (5). In addition, infrastructural limitations, including unreliable internet connectivity and inadequate electricity supply, further constrain digital transformation in rural regions (3).

Another critical dimension is the role of digital technologies in promoting sustainable agriculture and rural development. The integration of AI, precision farming, and smart agricultural systems has been shown to enhance farm productivity, reduce input costs, and improve environmental outcomes. Moreover, these technologies contribute to rural development by generating employment opportunities, increasing farmers' incomes, and supporting climate-resilient agricultural practices (3). In addition to technological and infrastructural constraints, issues related to accessibility, inclusiveness, and capacity building significantly influence the effectiveness of digital transformation in agriculture. Smallholder farmers, who constitute a major proportion of the agricultural workforce in developing countries, often face challenges in accessing digital platforms due to language barriers, low levels of education, and limited exposure to information and communication technologies. These challenges not only restrict the adoption of advanced tools but also limit farmers' participation in digital ecosystems, thereby reinforcing existing inequalities in the agricultural sector (6).

Moreover, the success of digital agriculture largely depends on the availability of institutional support systems such as extension services, training programs, and policy interventions. Strengthening digital extension services can play a pivotal role in enhancing farmers' awareness and capacity to adopt emerging technologies. Empirical evidence suggests that targeted training programs and farmer-centric communication strategies significantly improve technology acceptance and utilization by addressing knowledge gaps and building trust among farming communities (6). In this context, government initiatives and development programs aimed at promoting digital inclusion are crucial for accelerating agricultural transformation. Another important aspect is the alignment of digital agriculture with sustainability goals. The adoption of smart technologies, including AI-based decision support systems and IoT-enabled monitoring tools, contributes to efficient resource management, reduced environmental impact, and improved resilience to climate change. These advancements are closely linked to the achievement of Sustainable Development Goals (SDGs), particularly those related to zero hunger, climate action, and responsible consumption and production (7). By enabling precision input use and real-time decision-making, digital technologies support the sustainable intensification of agriculture while minimizing ecological degradation.

Building on these perspectives, digital literacy must be understood as more than a technical skill; it is a multidimensional capability encompassing the ability to access, evaluate, and effectively apply digital information in agricultural decision-making. Farmers with higher levels of digital literacy are better positioned to utilize mobile applications, digital marketplaces, and advisory platforms, thereby improving productivity and market integration. Conversely, limited digital competence constrains the effective use of such technologies, even when they are accessible, highlighting the need for capacity-building initiatives alongside technological deployment (8). The diffusion of digital innovations in agriculture also exhibits unequal patterns across regions and farmer categories. Large-scale farmers and agribusiness enterprises tend to adopt advanced technologies more rapidly due to better financial resources, access to information, and stronger institutional linkages, whereas smallholder farmers often lag behind. This disparity underscores the need for inclusive digital strategies that address affordability, accessibility, and usability concerns. Tailored interventions, such as localized content, user-friendly interfaces, and support for vernacular languages, are essential to bridging the digital divide and ensuring equitable access to technological benefits (9).

In addition, emerging digital platforms and mobile-based applications are playing an increasingly important role in transforming agricultural practices. These platforms provide real-time information on weather conditions, pest management, input prices, and market trends, enabling farmers to make informed decisions. The integration of digital advisory services with traditional extension systems has demonstrated significant potential in improving knowledge dissemination and farm outcomes. However, the effectiveness of such platforms largely depends on farmers' trust, perceived reliability of information, and sustained engagement with digital tools (10).

Furthermore, policy frameworks and governance structures play a critical role in shaping digital transformation in agriculture. Governments and international organizations have introduced various initiatives to promote digital agriculture through infrastructure development, financial incentives, and institutional support. In the Indian context, programs such as Digital India and the National Agriculture Market (e-NAM) aim to enhance digital connectivity and market access for farmers. Nevertheless, their success depends on effective implementation, coordination among stakeholders, and continuous monitoring to ensure inclusivity and impact (11). Another emerging area of interest is the integration of digital technologies with climate-smart agriculture. With increasing climate uncertainties, tools such as remote sensing, predictive analytics, and decision support systems are being utilized to enhance adaptive capacity and risk management. These technologies enable farmers to anticipate climatic risks, optimize resource use, and adopt resilient agricultural practices. Consequently, digital agriculture is increasingly recognized as a key enabler of sustainable and climate-resilient food systems (12).

Despite the expanding body of literature on digital agriculture, there remains a lack of comprehensive synthesis focusing specifically on the intersection of digital literacy and technology adoption. Existing studies often examine technological innovations or adoption determinants in isolation, without adequately addressing the role of human capital and digital competencies. Therefore, a systematic literature review is necessary to consolidate existing knowledge, identify research gaps, and provide a holistic understanding of how digital literacy influences technology adoption in agriculture. Accordingly, this review aims to systematically analyze the existing literature on digital literacy and technology adoption in agriculture, with a focus on identifying key determinants, challenges, and opportunities. The study seeks to contribute to the academic discourse by integrating insights from diverse research streams and offering evidence-based

recommendations for policymakers, practitioners, and researchers to promote inclusive and sustainable digital transformation in the agricultural sector.

2. Problem focus

Despite the rapid advancement of digital technologies in agriculture, their adoption and effective utilization remain uneven and limited**,** particularly among smallholder farmers in developing regions. While innovations such as artificial intelligence, Internet of Things, and precision farming have demonstrated significant potential to enhance productivity, sustainability, and resilience, their benefits are not fully realized due to low levels of digital literacy among farmers**.** Many farmers lack the necessary skills to access, interpret, and apply digital information, which restricts their ability to engage with modern agricultural technologies.

In addition to skill limitations, several structural and institutional barriers further constrain technology adoption. These include inadequate digital infrastructure, poor internet connectivity, limited access to digital devices, and insufficient extension support systems. Economic constraints, such as the high cost of technology and limited financial resources, also discourage farmers from adopting advanced tools. Moreover, socio-cultural factors, including language barriers, resistance to change, and lack of trust in digital platforms, contribute to the slow diffusion of innovations.

Another critical issue is the presence of a persistent digital divide, where large-scale farmers and agribusinesses benefit more from digital technologies compared to smallholder farmers. This inequality limits inclusive agricultural development and reinforces existing socio-economic disparities. Furthermore, existing research often examines either technological advancements or adoption behavior independently, with limited emphasis on the integrated role of digital literacy in influencing technology adoption**.** Therefore, there is a need to systematically analyze how digital literacy interacts with technological, socio-economic, and institutional factors to influence adoption outcomes. Addressing this gap is essential for developing effective strategies, policies, and interventions that can promote inclusive, efficient, and sustainable digital transformation in agriculture

3. METHODOLOGY

The methodology for this systematic literature review (SLR) on digital literacy and technology adoption in agriculture follows a structured and transparent approach to ensure a comprehensive analysis of existing research. This study employs the PRISMA framework, which facilitates the identification, screening, eligibility assessment, and final inclusion of relevant studies. The Scopus database was selected as the primary source due to its extensive coverage of high-quality, peer-reviewed academic literature across multiple disciplines. The inclusion and exclusion criteria are presented in (Table 1).

The recent trend in digital agriculture and technology adoption has gained considerable momentum, particularly after 2020, with numerous studies emphasizing the role of digital literacy in enhancing agricultural productivity, sustainability, and rural development. Research from this period provides a strong foundation for understanding the evolution of digital technologies in agriculture, especially in areas such as smart farming, precision agriculture, and farmer adoption behavior.

The search strategy was designed to capture relevant studies using a combination of keywords, including digital literacy, ICT literacy, technology adoption, digital agriculture, smart farming, and farmer adoption behavior. This approach ensures the inclusion of studies that address

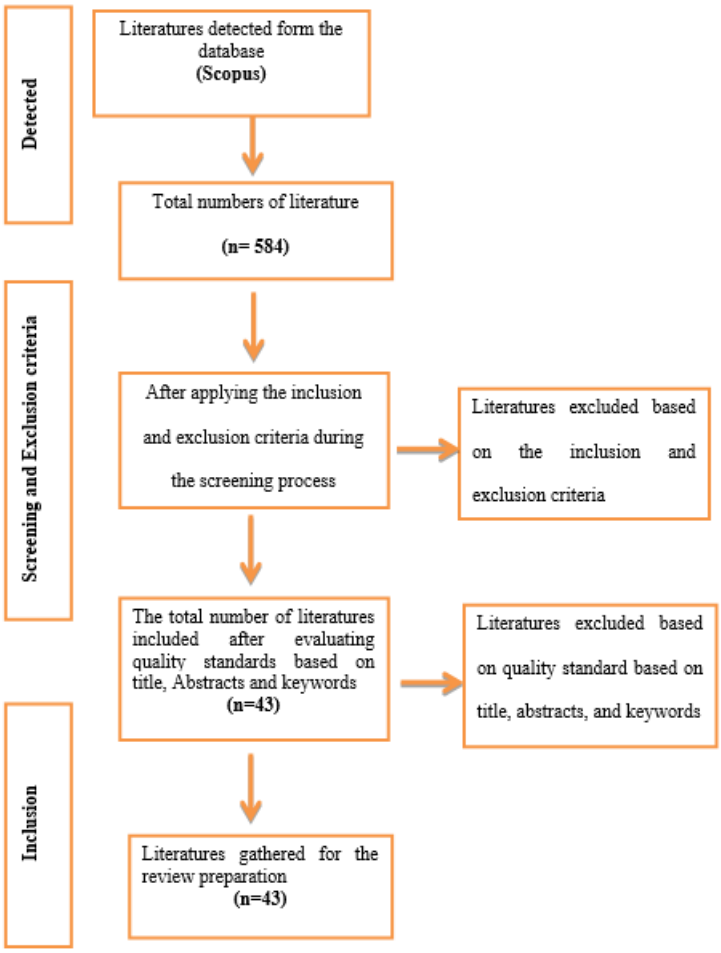

Fig. 1. The PRISMA flowchart.

both digital competencies and their role in facilitating technology adoption in agriculture. The initial search of the database retrieved a total of 584 articles. These articles underwent a systematic filtering process, as outlined in the PRISMA flowchart shown in (Fig. 1).

By illustrating how studies were selected at each stage, the flowchart ensures transparency and reproducibility of the review methodology. The first step of the process was identification, during which 584 research articles were retrieved from the Scopus database. (Table 2) presents the list of keywords employed during the database literature searches. This indicates that Scopus served as the primary source for collecting research articles related to digital literacy and agricultural technology adoption. Following this, the literature pool was refined during the screening phase by applying predefined inclusion and exclusion criteria. As a result, a substantial number of articles were excluded due to irrelevance, duplication, or failure to meet the specified criteria.

In the subsequent screening phase, the remaining articles were evaluated based on their titles, abstracts, and keywords to ensure alignment with the research objectives. This step ensured that only studies with direct relevance to digital literacy and technology adoption in agriculture were retained. Consequently, a large proportion of articles were excluded for not meeting the quality and relevance standards, resulting in the final inclusion of 43 articles**.**

Table 1. Inclusion and exclusion criteria

Databases	**Inclusion**	**Exclusion**
Time span	2020 – 2026	<2020
Document type	Articles, Review	Conference papers, Book chapters, Books, Editorials, Conference reviews
Languages	English	Non- English

		And others all
Source type	Journal	Trade journal Book series Book Conference proceeding
Publication stage	Final	Article in press
Open access	All open access	Others

Table 2. The list of keywords employed during the database literature searches

DATABASES	KEYWORDS	TOTAL NUMBER OF ARTICLE
Scopus	"Digital Literacy" OR "ICT Literacy") AND "Technology Adoption" OR "Innovation Adoption" AND "Agriculture" OR "Digital Agriculture" OR "Smart Farming" AND "Farmers" OR "Adoption Behavior"	584

4. **Justification for inclusion criteria**

The inclusion criteria for this systematic literature review were carefully defined to ensure the methodological rigor, reliability, and scientific validity of the selected studies. Only peer-reviewed journal articles and review papers were included in the analysis, as these sources typically undergo stringent editorial screening and rigorous peer-review processes. Such procedures enhance the credibility, accuracy, and scholarly integrity of published research, thereby ensuring that the findings included in this review are based on high-quality evidence. In contrast, other forms of literature, such as conference proceedings, book chapters, editorials, and reports, were excluded due to potential inconsistencies in review standards and variations in methodological quality. Although these sources may provide valuable insights and emerging perspectives, they often lack the uniformity and depth of peer-reviewed journal publications. Excluding these sources helped maintain consistency in quality assessment and improved the comparability of findings across the selected studies.

Furthermore, the review was limited to articles published in the English language to ensure clarity, consistency, and ease of interpretation. While this may have led to the exclusion of relevant studies published in other languages, it minimized the risk of misinterpretation and ensured uniform analysis. The selected time frame (2020–2026) was chosen to capture the most recent developments in digital literacy and technology adoption in agriculture, particularly in the context of rapid digital transformation and increasing emphasis on smart farming practices. Additionally, only open-access and fully published (final stage) articles were considered to ensure accessibility and transparency in the review process. This allowed for complete evaluation of the studies without restrictions, thereby enhancing the reproducibility of the research.

It is acknowledged that these inclusion criteria may limit the breadth of the review by excluding potentially relevant studies from non-journal sources or earlier periods. However, this approach was necessary to maintain a high standard of quality, consistency, and reliability in the analysis. Future research may expand the scope by incorporating additional sources, such as high-quality conference proceedings or book chapters, provided they meet established academic and methodological standards.

5. RESULT AND DISCUSSION

5.1 Network of Co-authorship (Authors)

The co-authorship network illustrates the collaborative relationships among researchers working in the domain of digital literacy and technology adoption in agriculture. In this visualization, nodes represent individual authors, while the connecting lines indicate co-authored publications. The structure of the network reflects an active research community with established patterns of academic collaboration (fig2).

The network is divided into two major clusters, indicating the presence of distinct research groups. The first cluster (red) includes authors such as Rakshit Krishanu, Bhatt Babita, Qureshi Israr, Shalini, and Manoharan Bhupesh. This cluster shows a high density of interconnections**,** suggesting strong collaborative relationships and frequent co-authorship among its members. The close-knit structure implies that these authors share similar research interests and contribute collectively to specific themes within the field. The second cluster (green) comprises authors such as Parthiban Rishikesan, Basak Jayanta, Bandyopadhyay Somprakash, and Jaikumar Saravana. This group also demonstrates consistent collaboration, though with comparatively fewer internal linkages than the first cluster. Nevertheless, the presence of multiple connections indicates a stable and ongoing pattern of cooperation among these researchers.

A key feature of the network is the central role of Parthiban Rishikesan, who acts as a linking or bridging author between the two clusters. This author connects otherwise separate research groups, facilitating knowledge exchange and enhancing the overall connectivity of the network. Such a role is crucial in promoting interdisciplinary understanding and supporting the integration of research findings across different areas of digital agriculture.

Overall, the network exhibits a cluster-based collaboration pattern, where strong interactions exist within groups, while cross-group collaboration is relatively limited and dependent on specific authors. The absence of a single dominant author

and the presence of multiple interconnected contributors indicate a collective and collaborative research environment**.** Furthermore, the network suggests potential opportunities for expanding collaboration across clusters, which could strengthen research outcomes and accelerate the adoption of digital technologies in agriculture.

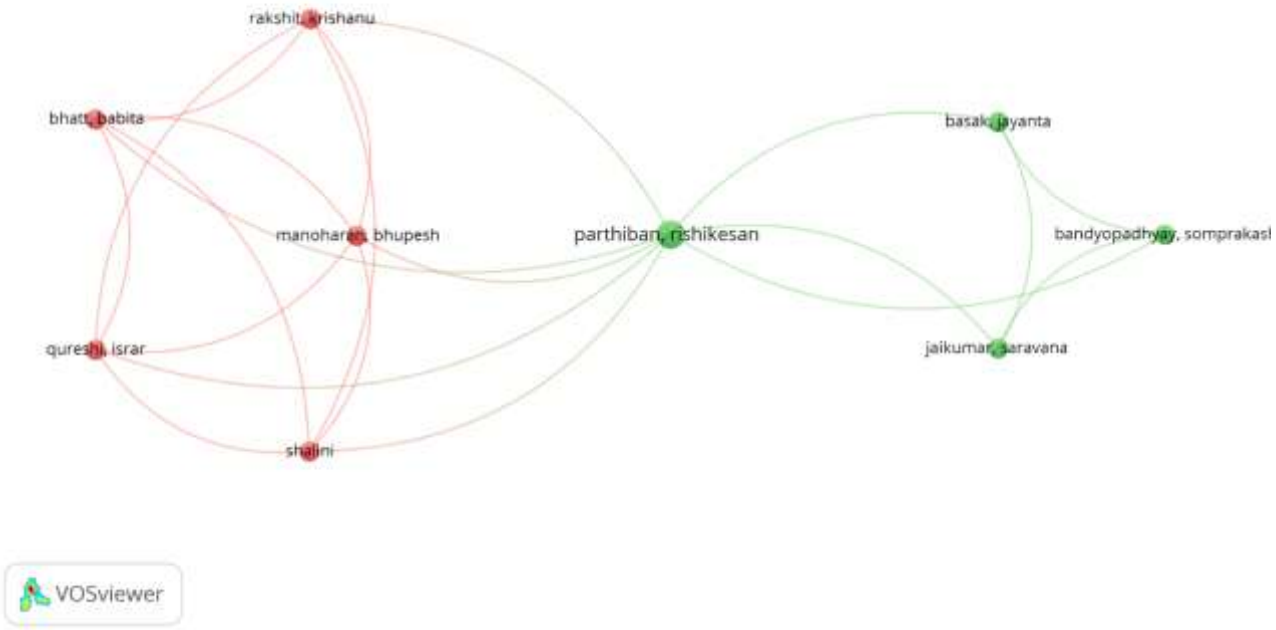

Fig. 2. **Network of Co-authorship (Authors)**

5.2 Co-occurrence of Author Keywords

The co-occurrence network of author keywords illustrates the conceptual structure and major research themes within the field of digital literacy and technology adoption in agriculture (Fig. 3). In this visualization, nodes represent frequently used keywords, while the links between them indicate their simultaneous occurrence within the same studies. The clustering of keywords highlights the emergence of distinct thematic areas and their interrelationships. The network reveals multiple thematic clusters**,** each representing a specific research focus. One prominent cluster centers around agriculture, precision farming technology, and entrepreneurship, indicating a strong emphasis on technology-driven agricultural practices and innovation. The linkage of these terms suggests that modern agricultural development is closely associated with advanced farming techniques and entrepreneurial activities.

Another significant cluster includes keywords such as ICT, farmers, and awareness, reflecting the importance of information and communication technologies in enhancing farmers' knowledge and capacity. This cluster emphasizes the role of digital literacy in improving access to information and supporting the adoption of new agricultural technologies. A central node in the network is India, which connects multiple clusters, indicating that a considerable portion of the research is geographically focused and that India serves as a key context for studies related to digital agriculture and technology adoption. The strong connections between India, ICT, and development further highlight the role of digital tools in driving agricultural and rural development.

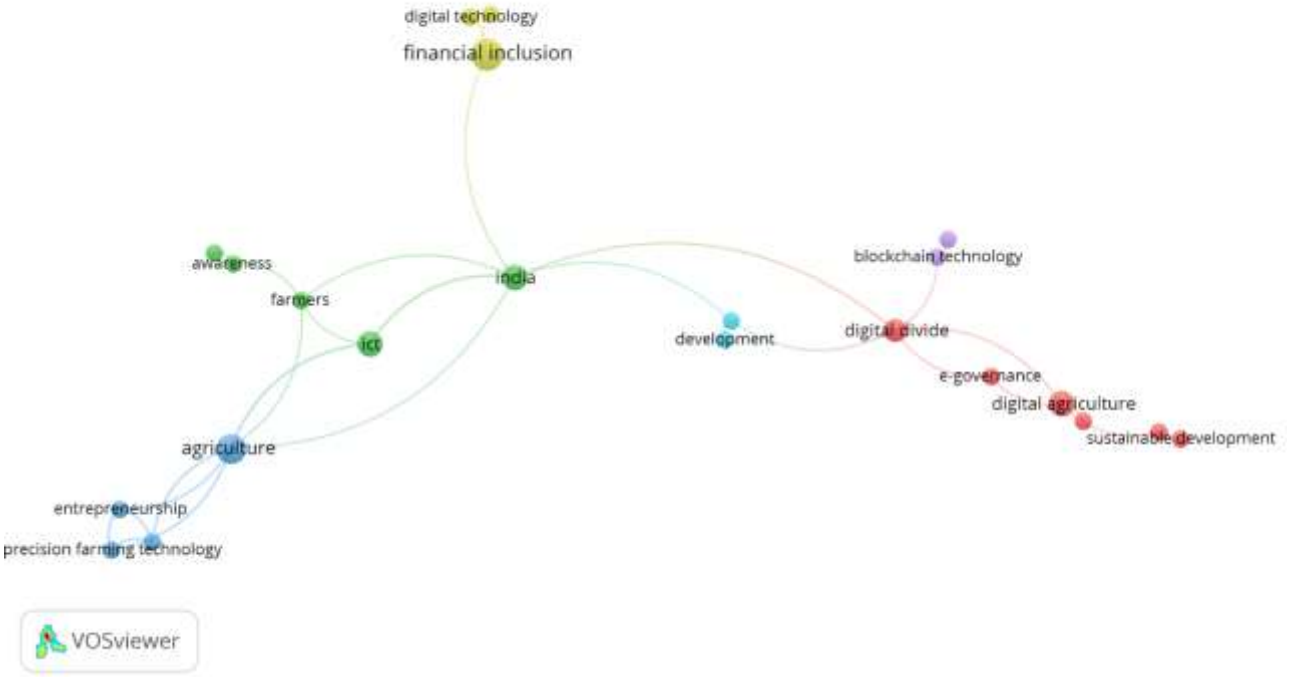

Fig. 3. **Co-occurrence of Author Keywords**

Additionally, another cluster comprising digital divide, e-governance, digital agriculture, and sustainable development reflects broader socio-economic and policy-oriented dimensions of the field. The presence of blockchain technology linked to this cluster suggests emerging interest in advanced digital solutions for improving transparency, efficiency, and sustainability in agricultural systems. The inclusion of financial inclusion and digital technology as connected keywords indicates the growing recognition of digital finance and technological access as critical enablers of agricultural transformation. Overall, the network demonstrates that research in this domain is multidimensional**,** integrating technological, socio-economic, and policy perspectives. The interconnected nature of keywords suggests a holistic and interdisciplinary research approach**,** where digital literacy, technological innovation, and institutional support collectively contribute to the advancement of agriculture

5.3 Citation Analysis by Countries

The citation network by countries illustrates the global distribution of research contributions in the field of digital literacy and technology adoption in agriculture (Fig. 4). In this visualization, each node represents a country, while the links between nodes indicate citation relationships, reflecting the flow of knowledge and academic influence across regions. The size of the nodes corresponds to the citation impact, with larger nodes indicating higher influence within the research domain. The network highlights India as the most prominent and central country, with the largest node size and the highest number of citation linkages. This indicates that India plays a dominant role in shaping the research landscape**,** contributing significantly to the literature and acting as a key hub for knowledge dissemination. The strong connections between India and countries such as Italy, the United States, Saudi Arabia, and Australia suggest active academic exchange and citation relationships.

Countries like Italy and Australia also demonstrate notable citation linkages, indicating their important contributions and engagement in the field. The presence of connections between Italy, Germany, and the United States reflects a collaborative and interconnected research environment among developed nations, particularly in advancing digital agricultural practices and policy frameworks. Additionally, countries such as Saudi Arabia, Tanzania, Morocco, and Togo are linked to the network, representing emerging contributors to the field. Although their node sizes are smaller, their connections with central countries like India indicate growing participation and integration into the global research community.

The inclusion of countries like Norway with relatively fewer connections suggests limited but existing contributions to the domain. Overall, the network demonstrates a globally distributed yet uneven citation structure, where a few countries act as major knowledge hubs while others are gradually increasing their presence. In conclusion, the citation network reflects a strong centralization around key countries**,** particularly India, alongside expanding international linkages. This

pattern indicates both the concentration of research influence and the potential for increased global collaboration to enhance the development and dissemination of knowledge in digital agriculture.

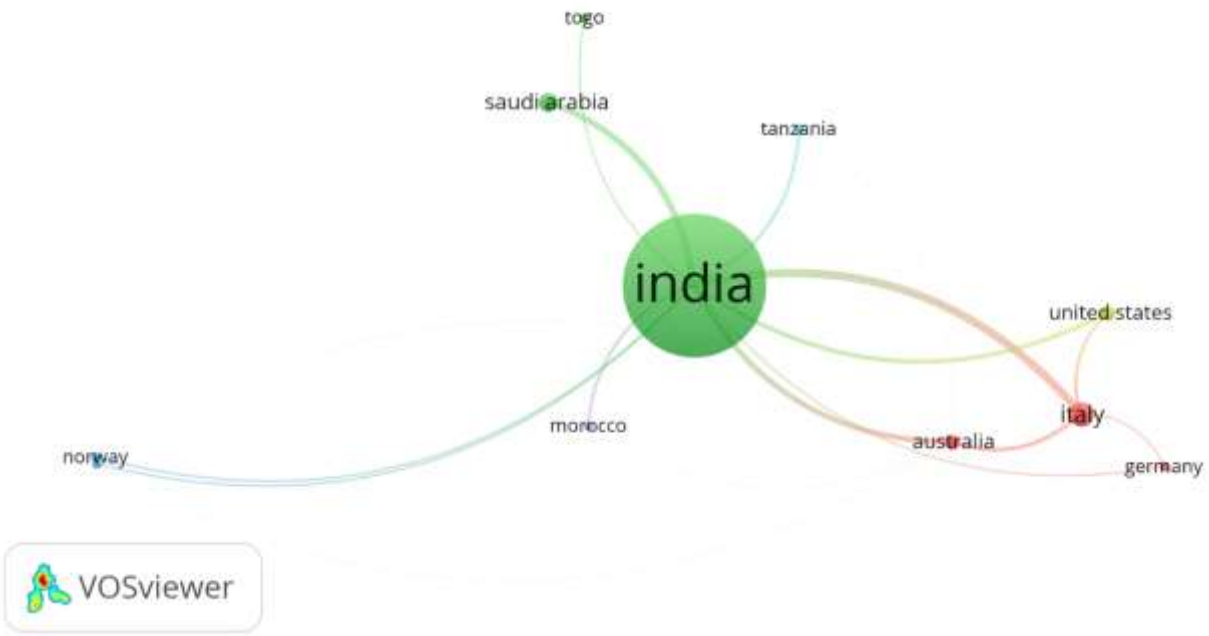

Fig. 4. Citation Analysis by Countries

5.4 Bibliographic Coupling (Authors)

The bibliographic coupling network of authors illustrates the intellectual connections among researchers based on shared references cited in their publications within the field of digital literacy and technology adoption in agriculture (Fig. 5). In this visualization, nodes represent authors, and the links between them indicate the extent to which they cite similar literature. Stronger connections suggest a higher degree of similarity in research focus and theoretical grounding. The network reveals a clustered structure, indicating the presence of multiple groups of authors who share common intellectual foundations. A densely connected core is observed around authors such as Parthiban Rishikesan, Anand Sruthy, Asrani Chavi, and Fiano Fabio. The close proximity and strong linkages among these authors suggest that they rely on similar references and contribute to closely related research themes, particularly in areas associated with digital agriculture and technology adoption.

Another group of authors, including Johri Amar and Dhillon Manju, forms a comparatively distinct cluster that is moderately connected to the core network. Their linkage indicates partial overlap in cited literature, suggesting that while their research aligns with the broader field, it may focus on more specific or differentiated aspects. Additionally, authors such as Amar Amritesh Kumar appear more peripherally connected, indicating a relatively narrower or specialized engagement with the shared knowledge base. The weaker connections of such authors suggest limited overlap in references with the central cluster, highlighting diversity in research perspectives within the field.

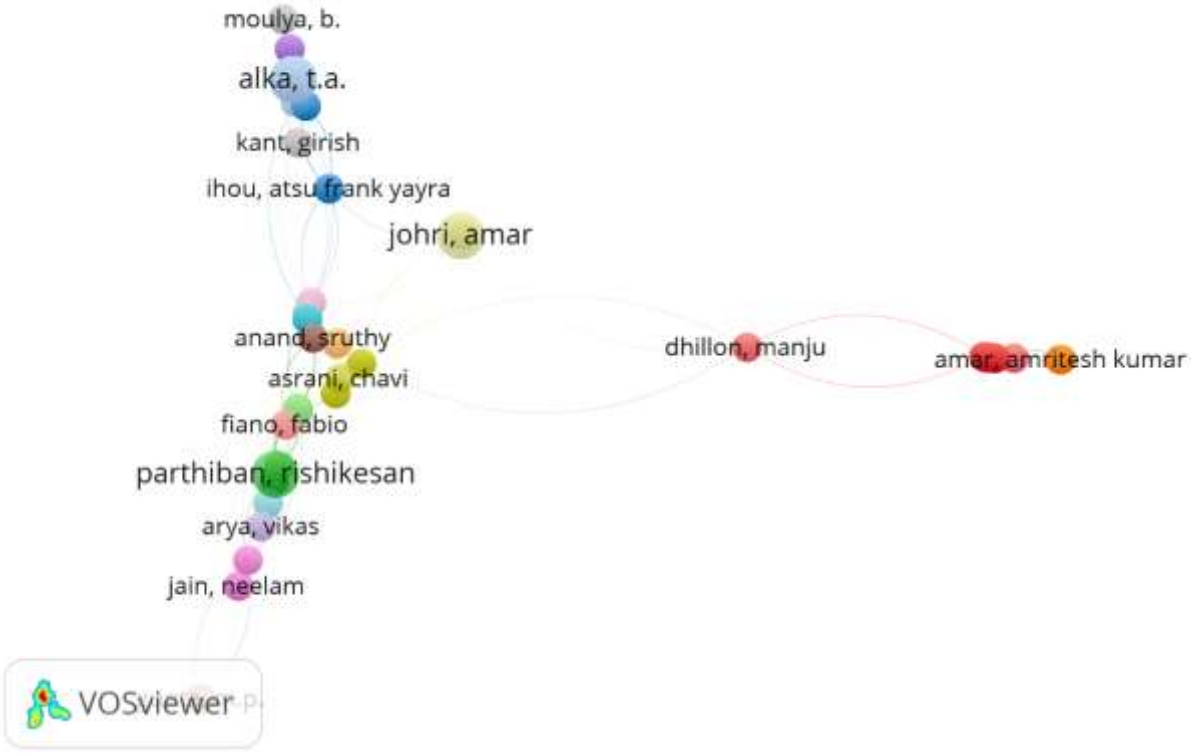

Fig. 5. Bibliographic Coupling (Authors)

The network also includes several smaller nodes representing authors with fewer connections, reflecting emerging or less integrated contributions. Despite this, the overall structure demonstrates a shared intellectual base among the majority of researchers, with varying degrees of connectivity. In summary, the bibliographic coupling network indicates that research in this domain is intellectually cohesive yet diverse**,** with a strong central group of authors contributing to core themes and several peripheral contributors expanding the scope of the field. This pattern highlights both the consolidation of knowledge and the presence of evolving research directions, suggesting opportunities for further integration and interdisciplinary exploration

5.5 Role of Digital Literacy in Agricultural Technology Adoption

Digital literacy constitutes a foundational determinant in shaping the adoption, utilization, and sustained integration of digital technologies in agriculture. It extends beyond basic technical skills to encompass the ability to access, critically evaluate, interpret, and apply digital information within complex farming environments. In the context of digital agriculture, this multidimensional capability enables farmers to engage effectively with emerging technologies such as artificial intelligence (AI), Internet of Things (IoT), precision farming tools, and mobile-based advisory platforms (12).

A high level of digital literacy enhances farmers' cognitive readiness and adaptive capacity**,** thereby positively influencing their perception of the usefulness and ease of use of technologies two key determinants highlighted in the Technology Acceptance Model (TAM). Digitally literate farmers are better equipped to interpret real-time data, utilize decision-support systems, and integrate digital insights into farm management practices, ultimately improving productivity and resource efficiency (13).

Furthermore, digital literacy facilitates information symmetry by reducing knowledge gaps between farmers and market actors. Through access to digital platforms, farmers can obtain timely information on weather conditions, pest outbreaks, input availability, and market prices, thereby enhancing decision-making and minimizing risks (14). This capability is particularly crucial in addressing uncertainties associated with climate variability and market fluctuations. Another critical role of digital literacy lies in promoting financial inclusion and market integration. The ability to use digital financial services, such as mobile banking, digital payments, and online marketplaces, empowers farmers to participate in formal economic systems, access credit, and improve income stability (15). Additionally, digital literacy supports the adoption of e-governance platforms and digital extension services, thereby strengthening institutional linkages and improving service delivery.

Importantly, digital literacy acts as a catalytic intermediary that transforms technological availability into effective utilization. The mere presence of digital infrastructure and tools does not guarantee adoption; rather, it is the users' capacity to engage with these technologies that determines their impact. Therefore, digital literacy is central to achieving inclusive and sustainable digital transformation in agriculture (16).

5.6 Challenges in Digital Literacy and Technology Adoption

Despite its transformative potential, the integration of digital literacy and technology adoption in agriculture is constrained by a range of structural, socio-economic, institutional, and behavioral challenges**.** A primary barrier is the low level of digital competence among farmers, particularly smallholder farmers in developing regions. Limited educational attainment, lack of exposure to digital technologies, and insufficient training opportunities significantly restrict farmers' ability to adopt and effectively use digital tools (17). This challenge is further compounded by language barriers and content accessibility issues**,** as many digital platforms are not tailored to local languages or cultural contexts.

Infrastructure-related constraints represent another major challenge. Inadequate access to reliable internet connectivity, electricity, and digital devices continues to hinder the penetration of digital technologies in rural areas. These limitations contribute to a persistent digital divide, not only between urban and rural regions but also among different socio-economic groups (18).

Economic constraints also play a significant role in limiting adoption. The high cost of digital technologies**, i**ncluding hardware, software, and subscription-based services, poses a substantial barrier for resource-constrained farmers. Even when technologies are available, affordability issues prevent widespread adoption, particularly among smallholder farmers who operate under tight financial constraints. Institutional challenges further exacerbate these issues. Weak agricultural extension systems, limited availability of digital training programs**,** and inadequate policy support reduce the effectiveness of technology dissemination. The lack of coordination among stakeholders, including government agencies, private sector actors, and research institutions, also impedes the development of a cohesive digital ecosystem (19).

Behavioral and psychological factors add another layer of complexity. Farmers often exhibit risk aversion, resistance to change, and low trust in digital platforms**,** particularly when technologies are perceived as complex or unreliable. The absence of demonstrable benefits and peer influence further slows adoption rates. Additionally, disparities in resource access between large-scale and smallholder farmers contribute to uneven adoption patterns**,** reinforcing existing inequalities in the agricultural sector (20).

6. CONCLUSION

This systematic literature review provides a comprehensive synthesis of existing research on digital literacy and technology adoption in agriculture, highlighting their interconnected roles in driving agricultural transformation. The findings clearly demonstrate that digital literacy is not merely a complementary skill but a critical enabler that determines the extent to which farmers can access, understand, and effectively utilize digital technologies. The integration of digital tools such as ICT platforms, precision farming technologies, and data-driven decision systems has significantly enhanced agricultural productivity, efficiency, and sustainability. However, the effectiveness of these technologies is largely dependent on the digital competencies of end users. The bibliometric analysis further reveals that research in this domain is growing yet structurally clustered**,** with strong collaboration within specific research groups and limited cross-cluster interaction. The keyword co-occurrence analysis indicates that the field is inherently multidisciplinar**y**, encompassing technological, socio-economic, and policy dimensions, with particular emphasis on themes such as ICT, digital agriculture, financial inclusion, and sustainable development. Additionally, the citation analysis highlights the dominant contribution of countries like India**,** alongside increasing global participation, reflecting both the regional focus and expanding international relevance of the field.

Despite the promising potential of digital agriculture, the review identifies several persistent challenges that hinder widespread adoption. These include low levels of digital literacy, inadequate infrastructure, high costs of technology, institutional weaknesses, and socio-cultural barriers**.** The existence of a significant digital divide, particularly among smallholder farmers, underscores the need for inclusive and equitable strategies to ensure that the benefits of digital transformation are accessible to all stakeholders.In light of these findings, the study emphasizes the need for integrated and holistic interventions**.** Strengthening digital literacy through targeted training programs, improving rural digital infrastructure, and modernizing extension services are essential steps toward enhancing technology adoption. Furthermore, policy frameworks should prioritize inclusivity by addressing affordability, accessibility, and usability challenges, particularly for marginalized farming communities. Encouraging collaboration among researchers, policymakers, and practitioners can further accelerate innovation and knowledge dissemination. Overall, this review contributes to the academic discourse by providing a systematic and multidimensional understanding of how digital literacy influences technology adoption in agriculture. It highlights the importance of aligning technological advancements with human capabilities to achieve sustainable outcomes. Future research should focus on empirical validation, region-specific studies, and the development of context-driven models to better understand the dynamics of digital adoption. By addressing existing gaps and leveraging digital opportunities, agriculture can move toward a more resilient, inclusive, and technology-driven future

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