

DIGITAL TRANSFORMATION AND COLLECTIVE MARKET POWER: A BIBLIOMETRIC AND SYSTEMATIC REVIEW OF DIGITAL AGRICULTURAL MARKETING AND FARMER PRODUCER ORGANISATIONS

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ABSTRACT

Digital transformation is increasingly reshaping agricultural marketing by enabling farmers to access market information, price signals, buyers, digital services and new channels for product promotion and exchange. This study reviews research on digital agricultural marketing, with particular emphasis on digital platforms, emerging technologies and the role of Farmer Producer Organisations (FPOs) in strengthening collective market participation. A bibliometric and systematic literature review was conducted using Scopus-indexed publications during 2015–2025, following the PRISMA framework. From 1,672 identified publications, 107 peer-reviewed articles were selected for analysis using Biblioshiny, VOSviewer and Microsoft Excel. The findings indicate substantial growth in research after 2020, with ICT, social media, mobile applications, digital platforms, technology adoption and sustainability emerging as prominent themes. Digital technologies support market-information access, price discovery, product visibility, customer engagement, e-commerce and direct market linkages. FPOs emerge as an important institutional mechanism for converting individual digital access into collective marketing capabilities through aggregation, market-information dissemination, product promotion, buyer linkage, price negotiation and digital transactions. However, digital literacy, connectivity, infrastructure, affordability, organisational capability and trust remain important constraints. The review also reveals limited research directly examining FPO-led collective digital marketing and its measurable effects on market access, price realisation and marketing performance. The study integrates digital technology, agricultural marketing and FPO-based collective action into a unified research perspective and identifies priorities for future research towards more inclusive, competitive and sustainable agricultural market systems. It highlights the need for stronger empirical evidence on organisational capabilities, member participation, digital inclusion, and measurable market outcomes across agricultural contexts.

KEYWORDS: Digital transformation; Digital agricultural marketing; Digital platforms; Farmer Producer Organisations; Collective marketing; Sustainable agricultural markets

1. INTRODUCTION

India is one of the largest global producers of food and agricultural commodities, ranking 6th in the global grocery and food market, with nearly 70% contribution to total sales. The agricultural sector supports both domestic consumption and exports and involves a comprehensive value chain from procurement of inputs (seeds, fertilizers) to production, harvesting and final marketing. Hence, marketing plays a critical role in determining profitability and market efficiency. Traditionally, marketing relied on conventional media such as print, television and radio; however, it has now transitioned to digital platforms. The current digital marketing ecosystem includes e-commerce, social media marketing, pay-per-click (PPC), content marketing and search engine optimization (SEO). India's digital advertising revenue grew by 26% in 2019, reaching ₹13,683 crores, compared to an overall advertising growth of 9.4%. It was further projected to grow by 27% in 2020, exceeding ₹17,000 crores. The expansion of digital infrastructure has significantly accelerated this shift, with ~700 million internet users in 2020, expected to surpass 970 million by 2025 and about 666 million active users by 2023. Additionally, India's e-commerce market is projected to reach ₹7 trillion, driven by increased digital adoption. Digital marketing has been instrumental in the growth of companies such as Amazon, Flipkart, AgroStar, DeHaat and Ninjacart. Overall, the adoption of digital marketing is expected to enhance agricultural productivity, improve market access and drive sectoral growth (1). Digital agriculture and marketing platforms provide farmers with access to real-time

price data, market trends, buyer information and electronic trading platforms, thereby enhancing price discovery and reducing information asymmetry between farmers and traders (2, 3). Digital agriculture and marketing platforms, particularly through social media platforms such as Facebook, Instagram and Twitter(X), improves online visibility, strengthens brand identity and facilitates continuous communication with partners, distributors and customers (4, 5). It integrates community development, targeted advertising and content marketing strategies (6). Digital agriculture refers to the integration of information and communication technologies (ICT), mobile applications, digital platforms and data-driven tools to enhance farm productivity, market access and decision-making (7, 8). Digital marketing is an important component of digital agriculture that facilitates farmer-to-consumer linkages and improves price realization globally (9). Farmer Producer Organizations (FPOs) provide an important institutional mechanism for enabling smallholder farmers to participate collectively in digital agriculture and agricultural marketing. By aggregating farmers and their produce, FPOs can facilitate access to digital market information, online trading platforms, potential buyers and digital agricultural services[1]. This collective institutional role is particularly relevant for farmers who face constraints related to inadequate market information, weak bargaining power, limited access to technology and insufficient digital skills[2]. The integration of FPOs with digital agriculture can therefore help convert individual digital access into collective marketing capability. The literature specifically identifies FPOs as mechanisms for digital literacy, market-information dissemination, buyer identification, product promotion and coordination of digital marketing activities [3] The role of FPOs in digital agricultural marketing extends beyond providing access to individual digital tools. FPOs can create shared digital capabilities by combining member-level participation with organisational resources[4]. This may include maintaining digital communication groups, disseminating market information, creating collective digital content, managing social media pages, developing collective brands, coordinating online orders and maintaining buyer databases. Such institutional arrangements can reduce the digital burden on individual farmers and enable them to participate in markets that may otherwise be difficult to access independently[5]. FPOs can also contribute to digital inclusion through training, extension linkage and peer learning. The uploaded review reports that training, extension contact, regular access to market information and basic mobile skills are associated with greater awareness of digital agriculture and marketing platforms. [6]Within an FPO, experienced members can share knowledge about mobile applications, social media, e-commerce platforms and digital payment systems with other members. In this way, FPOs can function as knowledge-sharing and capacity-building networks as well as marketing institutions [7] The collective marketing function of FPOs is especially important for small and marginal farmers because aggregation can improve the scale and consistency of supply. A digitally enabled FPO can communicate available quantities and quality attributes to buyers, coordinate collection and logistics, negotiate collectively and support digital transactions[8]. These activities may reduce transaction costs and information asymmetry while improving the visibility of members' produce. However, the literature indicates that the effectiveness of this institutional pathway depends on digital infrastructure, member participation, organisational capability, leadership, financial resources, trust and training. FPOs should therefore be viewed as an enabling mechanism, not as an automatic guarantee of improved market outcomes [9]. By leveraging digital marketing tools to access real-time market information, pricing trends, buyer details and demand signals, farmers can reduce their dependence on traditional intermediaries and make informed marketing decisions. Furthermore, digital marketing reduces transaction costs and improves price realization by minimizing the role of middlemen, reducing storage and transportation constraints and enabling direct farmer- to-buyer linkages. Digital platforms such as e-Choupal, e-NAM, AGMARKNET, NAFED, IKISAN, UZHAVAN and Napanta mobile applications support farmers by providing better pricing information, facilitating payments and enhancing market access (10, 11). Digital Marketing also includes the promotion and sale of agricultural products through social media, e-commerce platforms, mobile devices, internet-based services and SMS-based market intelligence systems. These tools enhance farmers' negotiation power, improve price realization and support activities such as direct consumer interaction, price negotiation, logistics planning and market research. For FPO member farmers, the benefits of digital marketing can be strengthened through collective action, aggregation and coordinated market participation. An FPO can aggregate members' produce and use digital platforms to disseminate prevailing prices, demand conditions and buyer information. It can also coordinate product promotion, price negotiation, transportation, logistics and digital payments on behalf of members. Such collective digital marketing can improve product visibility, facilitate larger-volume transactions and potentially strengthen the bargaining position of farmers. Digital platforms such as e-NAM, e-Choupal, AGMARKNET, NAFED, IKISAN, UZHAVAN and NaPanta illustrate the broader digital ecosystem through which farmers can access market information, pricing information, payments and market linkages [10, 11].The FPO therefore has potential to function as a bridge between individual producers and wider digital markets rather than merely acting as a conventional aggregation institution. However, limited access to digital infrastructure remains a significant challenge. High data costs, low levels of digital literacy and limited smartphone penetration restrict farmers' ability to effectively utilize digital technologies (12, 13). Although digital marketing has the potential to increase household income, expand customer reach, reduce advertising costs and improve operational efficiency, its benefits are not equally distributed among all farmers. constraints such as inadequate digital skills, poor internet connectivity, limited content creation capabilities and socio-cultural barriers particularly in rural areas continue to hinder its effectiveness (14). Social media platforms play a crucial role in enhancing communication, expanding market access and fostering innovation in the agricultural sector (15). Farmers who participate in entrepreneurship and training programs demonstrate higher

levels of effectiveness in using social media for both social and business purposes, highlighting the importance of digital literacy and skill development (16). Farmers increasingly use social media to connect with peers, identify new markets, access information on agricultural technologies, monitor weather conditions and improve productivity.

1.1. Research Gap

Although previous studies have extensively examined digital agriculture, digital marketing, ICT adoption, social media and mobile applications, much of the existing research has focused on individual technologies, specific digital platforms or farmers' adoption behaviour. An important institutional gap remains concerning how smallholder farmers can collectively access and utilise digital agricultural and marketing platforms. In particular, the role of Farmer Producer Organizations (FPOs) in facilitating digital literacy, market-information access, collective digital marketing, buyer linkages, digital payments, product aggregation and price discovery has not been sufficiently synthesised. The available evidence suggests that FPOs can reduce individual-level barriers by providing shared training, market information and coordinated marketing services, but there is still limited empirical evidence directly linking FPO digital capability with measurable outcomes such as sales growth, marketing cost, price realisation, profitability and member income. Therefore, a stronger FPO-centred perspective is required to understand how digital technologies are converted into collective marketing capabilities and farmer level market outcomes [3].

1.2. Purpose of the Review

This review provides a comprehensive synthesis of the existing literature on digital agriculture and marketing platforms using bibliometric and systematic review approaches. It examines publication trends, thematic evolution, collaboration networks and the factors influencing adoption and utilisation of digital technologies in agricultural marketing. In addition, particular attention is given to Farmer Producer Organizations as collective institutional mechanisms that can facilitate digital literacy, market-information access, collective promotion, buyer linkages, digital transactions and improved market participation. The review therefore connects digital technology adoption with organisational capability and agricultural market outcomes, while identifying evidence gaps and future research directions for inclusive digital agricultural marketing.

1.3. Objectives

1. To examine the research trends in digital agriculture and digital marketing platforms.
2. To identify the major research themes related to digital agriculture and agricultural marketing.
3. To analyse the use and adoption of digital platforms by farmers.
4. To examine the role of digital platforms in improving farmers' access to market information and markets.
5. To examine the role and potential of Farmer Producer Organisations (FPOs) as collective institutional mechanisms for digital agricultural marketing, market access and price realisation.

2. Methodology

This study adopted a systematic literature review combined with bibliometric analysis to examine digital agriculture and marketing platform usage among farmers. The data for the study were collected from the Scopus database using keywords such as "digital agriculture," "digital marketing," "social media," "mobile applications," "ICT," "adoption," "usage," "engagement," and "agribusiness." Boolean operators such as "AND" and "OR" were used to refine the search results. To ensure the inclusion of relevant and high-quality studies, only peer-reviewed journal articles published in English between 2015 and 2025 were considered. The search was limited to studies related to agriculture and social sciences. After applying the inclusion and exclusion criteria, a total of 1,672 articles were initially identified, of which 107 articles were selected for the final analysis. The study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure a systematic and transparent selection process (17). The selected literature was analysed using **Biblioshiny**, **VOSviewer** and **Microsoft Excel** to examine annual scientific production, keyword co-occurrence, research trends, thematic patterns and collaboration networks. The findings were further synthesised thematically to identify the contribution of digital technologies and FPOs to collective marketing, market access, information sharing, buyer linkages and digital transactions, as well as the major research gaps and future research priorities.

3. RESULT

Figure 2. presents the keyword co-occurrence network illustrating the relationships among major research themes such as ICT adoption, digital agriculture and marketing platforms. The size of the nodes indicates the frequency of keyword occurrence, while larger nodes such as "social media," "information and communication technology (ICT)," "mobile applications," and "farmers" represent dominant research areas in the field. The network is divided into clusters representing different thematic areas. The red cluster highlights ICT, social media and digital tools used by farmers; the green cluster focuses on sustainability, policy and rural development; the yellow cluster represents awareness, education and behavioural aspects; the blue cluster captures advanced technologies such as precision agriculture, artificial intelligence and remote sensing; and the purple cluster reflects land use and digital adoption. The close connections among these clusters indicate strong relationships between digital technologies and agricultural practices. Overall, the network demonstrates that digital agriculture and marketing platforms play a significant role in improving information flow, decision-making and market access among farmers.

Figure 3. illustrates the co-authorship network, highlighting collaborations among researchers in the field of digital agriculture and marketing platforms. The network reveals two distinct clusters of active researchers, indicating collaborative research groups. Leeuwis Cees appears as a key linking author between the two clusters, acting as a bridge that connects different research groups. The red cluster includes authors such as McCampbell, Vanlauwe, Schut, Van Schagen, Blomme and Gaidashova, representing a closely collaborating group. The green cluster comprises Lemaga, Tafesse, Sharma, Struik, Lie and Van Mierlo, forming another group of frequently collaborating researchers. The presence of a central linking author indicates knowledge exchange and collaboration across research groups. Overall, the network demonstrates strong collaboration within clusters, with limited but important connections between them.

Figure 4. illustrates the evolution of key research themes related to digital agriculture and marketing platforms over time. During the period 2018–2020, research primarily focused on mobile phones, farmers and basic communication technologies, indicating an early stage of digital adoption in agriculture. This phase emphasized the development of infrastructure, awareness creation and improving access to digital tools in rural areas. Between 2020 and 2022, the focus shifted towards technology adoption, innovation and information and communication technologies (ICT). This period reflects a transition from basic access to the effective utilization of digital tools, influenced by behavioural, institutional and economic factors affecting farmers' adoption of technology. Social media and smallholder-related themes also gained importance, highlighting the growing role of digital platforms in information sharing and market communication. In recent years (2023–2024), research themes have increasingly converged around digital agriculture, sustainability, rural development and market-oriented applications. This indicates a shift from technology adoption to impact-oriented outcomes, such as improved market access, increased income and sustainable agricultural practices. Overall, the trend demonstrates a clear progression from basic digital access to advanced utilization of digital agriculture and marketing platforms, emphasizing their growing importance in enhancing farmer livelihoods and agricultural development.

Figure 5. illustrates the frequency of key terms from 2015 to 2025, highlighting shifts in research focus related to digital agriculture and marketing platforms. During the early period (2015–2017), the occurrence of key terms such as ICT, social media, technology adoption and sustainability remained relatively low, indicating the initial stage of research development in this field. From 2018 onwards, there was a noticeable increase in the frequency of these terms, reflecting growing academic interest in digital technologies in agriculture. Since 2020, social media has shown a significant rise, indicating its increasing importance in information dissemination, communication and market linkage among farmers. Similarly, ICT and technology-related terms have demonstrated steady growth, emphasizing the expanding role of digital tools in agricultural practices. Terms related to smallholder farmers and mobile technologies have also increased substantially, particularly after 2021, highlighting the importance of mobile-based platforms in improving access to markets, information and services. During the period 2022–2025, the research focus appears to have reached a more mature stage, with increased emphasis on sustainability, resilience and long-term agricultural development. Overall, the trend indicates a clear transition from traditional agricultural themes to a stronger emphasis on digital technologies, farmer-centric approaches and sustainable development within the framework of digital agriculture.

Figure 6. presents the annual scientific production from 2015 to 2025, illustrating the growth of research in digital agriculture and marketing platforms. During the initial period (2015–2017), the number of publications was relatively low and fluctuating, indicating that the research field was in its early stage of development. From 2018 onwards, there was a noticeable increase in the number of publications, reflecting growing academic interest in digital technologies in agriculture. A slight decline is observed around 2020, followed by a significant increase from 2021 onwards. Between 2021 and 2023, the number of publications increased rapidly, indicating strong research momentum in this domain. The continued rise in publications highlights the increasing importance of digital technologies, innovation and sustainability in modern agricultural systems. In 2025, publication output remains high despite a slight dip in 2024, indicating sustained research interest in the field. Overall, the trend demonstrates a steady growth in scientific output, emphasizing the expanding importance of digital agriculture and marketing platforms in agricultural research and development.

3.1. Awareness of Digital Agricultural and Marketing Platforms

Farmers who receive proper training, maintain regular contact with extension personnel, frequently access market information and possess basic mobile usage skills demonstrate higher levels of awareness regarding digital agriculture and marketing platforms (2, 23). Agri-food enterprises also show a high level of awareness and adoption of digital platforms, with significant use of social media channels such as Instagram, Twitter/X and Facebook for marketing and communication purposes (6, 24). Despite increasing awareness, many farmers remain familiar with only a limited number of digital tools. Studies indicate that a large proportion of farmers recognize only a few widely known platforms such as e-NAM, e-Choupal, AGMARKNET, Uzhavan app and NaPanta, while awareness of a broader range of digital applications remains low (10, 25). This limited awareness restricts the effective utilization of available digital resources. Training, exposure and practical experience play a significant role in improving farmers' awareness and understanding of digital platforms (26). Farmers who participate in training programmes or receive extension support tend to have better knowledge of digital tools and market trends (12). Similarly, rural women entrepreneurs demonstrate moderate to high awareness of digital marketing tools, often gaining knowledge through social media platforms and community interactions (14, 27). Participation in agricultural training and entrepreneurship programmes further enhances farmers' awareness,

enabling them to utilize digital platforms for information sharing, networking and market access (16). However, awareness levels are influenced by external factors such as education, digital literacy, internet accessibility and socio-economic conditions (28, 29). Although awareness of digital platforms is gradually increasing, the depth of understanding remains limited among smallholder farmers. Many farmers possess only basic knowledge of digital tools such as e-commerce platforms, social media and online marketing techniques (30, 31). Therefore, there is a need for targeted awareness programmes, capacity-building initiatives and extension interventions to enhance farmers' knowledge and effective use of digital agriculture and marketing platforms.

3.2. Level of Usage of Digital Agriculture and Marketing Platforms

The use of digital agriculture and marketing platforms has been steadily increasing across both agricultural and non-agricultural sectors. Rural enterprises and small businesses are increasingly adopting digital platforms to promote products and communicate with customers (32). Among these, social media platforms are widely used due to their low cost, ease of use and ability to facilitate direct interaction with consumers (33, 34). Despite growing awareness, the level of usage of digital platforms among farmers remains moderate (35). Many farmers utilize basic functions such as sharing product information or communicating with buyers through social media, but the adoption of advanced digital marketing practices is still limited (36, 37). Digital platforms in agriculture include social media, e-commerce platforms, search engines and mobile-based applications, each serving different functions such as promotion, sales, communication and market access (38). Although the use of these platforms is increasing, their adoption is still in the early stages in many rural areas (39, 40). In contrast, business sectors demonstrate a higher level of adoption of digital platforms, particularly through social media, search engines and email marketing, which enable effective customer engagement and real-time feedback (41, 42). However, smaller enterprises and farmers often face challenges in adopting advanced digital tools due to limited technical knowledge, high implementation costs and concerns related to data security (43). Overall, while digital agriculture and marketing platforms are gaining importance, their effective utilization among farmers remains limited, indicating the need for improved digital literacy, infrastructure and institutional support.

3.3. Factors Influencing Adoption of Digital Agriculture and Marketing Platforms

The adoption of digital agriculture and marketing platforms among farmers is influenced by a combination of technological, socio-economic and behavioural factors. Key determinants include perceived usefulness, ease of use, awareness and trust in digital technologies (44, 45). Farmers are more likely to adopt digital platforms when they understand how these technologies function, can easily operate mobile-based applications and perceive clear benefits in terms of market access and information availability (46, 47). Farmers' use of digital tools such as social media platforms and mobile applications is also shaped by communication behaviour, attitudes and economic conditions. Factors such as education level, income, farm size, innovativeness and social participation significantly influence the adoption of digital technologies in agriculture (48, 49). In addition, motivational factors, innovation orientation and communication networks play an important role in determining farmers' use of digital platforms. The adoption of social media for agricultural marketing is not solely dependent on technological availability but also on farmers' willingness to engage and communicate effectively (50). Structural and infrastructural factors, including internet connectivity, access to reliable information and availability of digital services, further influence adoption. These factors determine how effectively farmers can utilize digital platforms for market access, decision-making and farm management (51). Overall, the adoption of digital agriculture and marketing platforms is a multidimensional process influenced by technological, economic and social factors, highlighting the need for integrated support systems to enhance adoption among farmers.

3.4. Accessibility of Digital Agriculture and Marketing Platforms

Despite significant advancements in digital technologies, accessibility remains a major challenge in rural areas. Limited internet connectivity, weak digital infrastructure and unstable network services continue to restrict farmers' access to digital agriculture and marketing platforms (52, 53). Digital platforms are designed to be accessible through mobile devices and online systems, allowing users to access information and services at any time (15). However, the actual accessibility of these platforms depends on factors such as internet availability, smartphone penetration and digital literacy (54). The increasing availability of smartphones and affordable internet services has improved access to digital information. Additionally, the use of local languages and user-friendly interfaces enhances the effectiveness of digital platforms. However, barriers such as low digital literacy, lack of trust and limited technical skills continue to hinder effective utilization (55). Furthermore, issues related to digital inclusion remain significant, as not all farmers have equal access to digital tools and services. Accessibility is influenced by factors such as education, income level, geographic location and technological awareness (56). Government-led digital public infrastructure initiatives and collective institutions such as Farmer Producer Organizations (FPOs) can play an important role in improving digital inclusion and access to agricultural markets. FPOs can act as collective platforms through which member farmers obtain access to digital technologies, market information, online trading opportunities and digital services[8]. This institutional support is particularly relevant for small and marginal farmers who may face difficulties in independently accessing smartphones, reliable internet services, digital applications and online markets. FPOs can facilitate awareness programmes and practical training on the use of mobile applications, social media, e-commerce platforms and digital market information services. They can also assist farmers in understanding online prices, identifying buyers, promoting agricultural products and undertaking digital transactions[12]. The collective nature of FPOs can further reduce individual-level barriers to digital marketing. Instead of each farmer independently searching for buyers or promoting small quantities of

produce, the FPO can aggregate members' produce and coordinate digital marketing activities. This can improve the visibility of agricultural products, facilitate larger-volume transactions and strengthen the bargaining position of member farmers[13]. FPOs may also provide institutional support for digital payments, transportation coordination, quality management, packaging and market information dissemination. Therefore, strengthening the digital capabilities of FPOs can contribute to more inclusive access to digital agriculture and marketing platforms and can support greater participation of smallholder farmers in modern agricultural markets [3]. Despite this potential, FPO-led digital marketing should not be assumed to produce uniform benefits. Connectivity, digital literacy, affordability, organisational capacity, governance, member participation and access to training can determine whether digital platforms are effectively used. The key research opportunity is therefore to examine whether stronger FPO digital capability produces measurable improvements in market access, number of buyers, sales volume, marketing cost, price realisation, profitability and member income[9]. Such outcome-oriented evidence remains limited and should be prioritised in future research. FPOs may additionally function as digital learning networks. Regular meetings, training programmes, farmer-to-farmer interaction and digital communication groups can support knowledge sharing on social media, mobile applications, online marketplaces and digital payment systems. Such peer-based learning can improve confidence and reduce the hesitation associated with adopting unfamiliar digital technologies. Social capital and ICT linkages in agricultural value chains provide supporting evidence for the importance of network-based knowledge exchange [7]. At the operational level, an FPO can disseminate market prices and demand information, identify buyers, promote aggregated produce, coordinate transportation and logistics, facilitate digital payments and support collective price negotiation. Such activities can reduce the transaction and information burden on individual farmers and increase the visibility and scale of marketable produce. The evidence on e-NAM and digital marketing applications also suggests that access to reliable market information can influence farmers' perceptions and market-related decision-making[10]. Farmer Producer Organizations can strengthen farmers' participation in digital agricultural marketing by combining collective aggregation with digital information, promotion and market-linkage functions. The reviewed evidence indicates that FPOs can serve as collective platforms through which members obtain access to digital technologies, market information, online trading opportunities and digital services. This role is particularly important for small and marginal farmers who may face difficulties in independently accessing smartphones, reliable internet services, digital applications and online markets[3].

4. DISCUSSION

4.1. FPOs as an Institutional Mechanism for Collective Digital Marketing

Peer influence plays a significant role in shaping farmers' behaviour in adopting digital agriculture and marketing platforms. It affects both online and offline decision-making processes, influencing how farmers access, share and utilize information. Social networks and community interactions contribute to the diffusion of knowledge and the adoption of digital technologies in agriculture (59, 60). Farmers strengthen their social and ecological resilience through peer interactions and community-based networks. These networks facilitate the exchange of information, experiences and best practices, thereby supporting the adoption of digital tools and technologies (61). Information about new technologies and digital platforms is often disseminated through informal channels such as interactions with fellow farmers, local markets, agricultural events and community organizations (62). Institutions such as farmer groups, food hubs, non-governmental organizations and cooperatives also play an important role in knowledge sharing and capacity building (63). Farmer Producer Organizations can further strengthen peer influence and community-based learning among farmers by providing structured platforms for interaction and knowledge sharing. Through regular meetings, training programmes, farmer-to-farmer interactions and digital communication groups, FPOs can facilitate the exchange of information on market prices, potential buyers, agricultural technologies and digital marketing practices. Experienced members can help other farmers understand and use mobile applications, social media platforms, online marketplaces and digital payment systems. Such peer-based learning can improve farmers' confidence and reduce the hesitation associated with adopting new digital technologies. FPOs can therefore function not only as collective marketing institutions but also as knowledge-sharing and capacity-building networks that support the adoption of digital agriculture among member farmers (Xie et al., 2021; Bhowmik and Hazari, 2026). Peer influence is strengthened through trust, participation and continuous interaction within networks, which enhances farmers' willingness to adopt digital innovations (64). Collaboration among researchers, institutions and extension systems further supports knowledge dissemination and innovation adoption (65). Social media platforms also contribute to improving communication efficiency and reducing information gaps by enabling farmers to share updates, experiences and market information in real time. Strong community networks facilitate faster adoption of digital agriculture technologies by enhancing communication and knowledge exchange among farmers (66).

4.2. Implications for Digital Agriculture and Extension

Digital Literacy Training:

Provide practical, hands-on training to farmers on using mobile apps, social media and e-market platforms. Focus on local-language content and continuous skill development (67).

Role of Extension Officers:

Extension officers should act as facilitators by creating awareness, offering technical guidance and supporting farmers in adopting digital tools and platforms (13).

Infrastructure Support:

Strengthen rural digital infrastructure by improving internet connectivity, ensuring affordable data access and promoting smartphone usage for better platform accessibility (68).

4.3. Policy Recommendations:

Promote inclusive digital agriculture policies, strengthen FPO-oriented training and capacity-building programmes, encourage public–private partnerships to enhance the digital capabilities of FPOs, and integrate FPO-led digital marketing initiatives into government schemes. Such institutional support can strengthen collective access to digital platforms, market information, digital payments and online markets, thereby improving the participation of smallholder farmers in emerging digital agricultural marketing systems.

4.4. Future Research Directions:

Further research should examine the role of Farmer Producer Organizations (FPOs) in facilitating the adoption and effective utilisation of digital agriculture and digital marketing platforms among member farmers. Priority areas include FPO digital capability, member digital literacy, collective branding, social media promotion, e-commerce, online buyer linkages, digital payments, product aggregation, logistics coordination and collective price negotiation. Research should also assess whether FPO-based digital marketing contributes to measurable outcomes such as improved price discovery, price realisation, sales, marketing efficiency, profitability, market participation and member income. Comparative studies across FPOs with different levels of digital infrastructure, governance, leadership, member participation and institutional support would help identify the conditions associated with successful digital transformation. Longitudinal and quasi-experimental studies could further establish whether digital marketing through FPOs generates sustained improvements rather than short-term increases in visibility or engagement.

4.5. Conceptual Pathway for FPO-led Digital Marketing

The evidence supports a conceptual pathway in which digital infrastructure and technologies enable FPO digital capability; FPO capability facilitates collective aggregation, digital literacy, branding, buyer linkage, online promotion and digital transactions; these activities improve information access, product visibility, customer engagement, trust and price discovery; and these market mechanisms may contribute to market access, sales, competitiveness and price realisation. Digital literacy, connectivity, organisational governance, financial capacity and member participation are expected to influence the strength of this pathway. This framework is conceptual and requires empirical testing before causal conclusions can be drawn.

5. CONCLUSION

Digital agriculture and digital marketing platforms are increasingly shaping the way farmers access information, communicate with market actors and participate in agricultural markets. The findings of the review indicate that digital technologies such as social media, mobile applications, ICT tools and digital platforms have considerable potential to improve market information access, product promotion, market linkages and communication. However, effective utilisation of these technologies continues to be influenced by digital literacy, internet connectivity, infrastructure availability, affordability and the socio-economic conditions of farmers. Within this digital transformation, Farmer Producer Organisations (FPOs) can serve as important institutional mechanisms for strengthening collective digital marketing among smallholder farmers. Through aggregation, dissemination of market information, collective promotion, branding, buyer linkages, digital transactions and coordinated marketing activities, FPOs can potentially help farmers participate more effectively in emerging digital markets. The review also highlights that the benefits of digital transformation depend not only on access to technology but also on organisational capacity, member participation, governance, financial resources and digital skills within FPOs. Nevertheless, the existing literature provides stronger evidence on digital access, information sharing and market connectivity than on measurable improvements in price realisation, profitability, sales and member income. Therefore, the contribution of FPO-led digital marketing to these economic outcomes requires further empirical validation. Future studies should focus on FPO-level digital capabilities, member digital literacy, collective marketing practices and measurable market outcomes using comparative, longitudinal and empirical approaches. Overall, the integration of FPOs with digital agricultural marketing platforms represents a promising pathway for promoting collective marketing, improved market access and inclusive digital transformation in agriculture. Strengthening digital infrastructure, organisational capabilities, training, governance and market-oriented services can enhance the ability of FPOs to support farmers in participating in increasingly digital agricultural markets.

Table 2. Inclusion and Exclusion criteria.

Fig. 1. PRISMA flowchart illustrating the literature selection process for the systematic review of digital agriculture and marketing platform usage among farmers.

Fig. 2. Keyword Co-occurrence network map.

Fig. 3. Co-authorship network diagram.

Fig. 4. Trend analysis of research themes.

Fig. 5. Word frequency over time.

Fig. 6. Annual scientific production.

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Table 1. Keywords combinations used and number of publications retrieved from the databases

Database	Search Terms	Number of Articles
Scopus	("digital agriculture" OR "digital marketing" OR "digital platforms" OR "social media" OR "mobile applications" OR "ICT") AND ("adoption" OR "usage" OR "engagement" OR "practices" OR "farmers" OR "agriculture" OR "agribusiness")	1672

Table 2. Inclusion and Exclusion criteria

Criteria	Inclusion	Exclusion
Time Period	2015-2025	Before 2015
Subject Area	Agriculture, Social sciences	All other subject areas
Document type	Peer-reviewed journal articles	Conference papers, book chapters, reviews, editorial
Publication stage	Final publication	Articles in Press
keywords	Digital agriculture, digital marketing, ICT, social media, technology adoption, smallholder farmers	Unrelated keywords
Source type	Academic journals	Trade journals, magazines
Language	English	Non-English
Access type	Open access	Restricted access

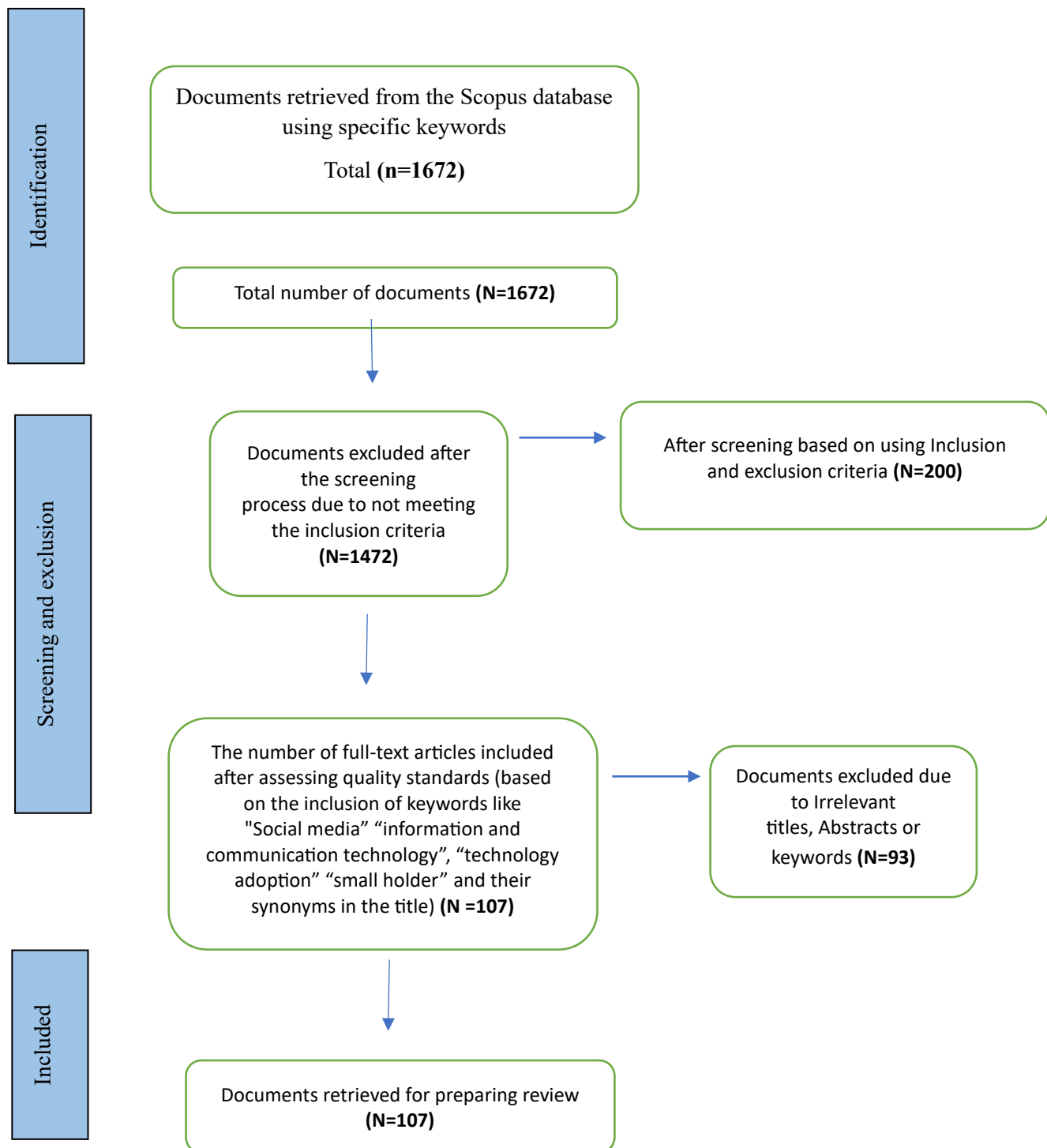


Fig. 1. PRISMA flowchart illustrating the literature selection process for the systematic review of digital agriculture and marketing platform usage among farmers

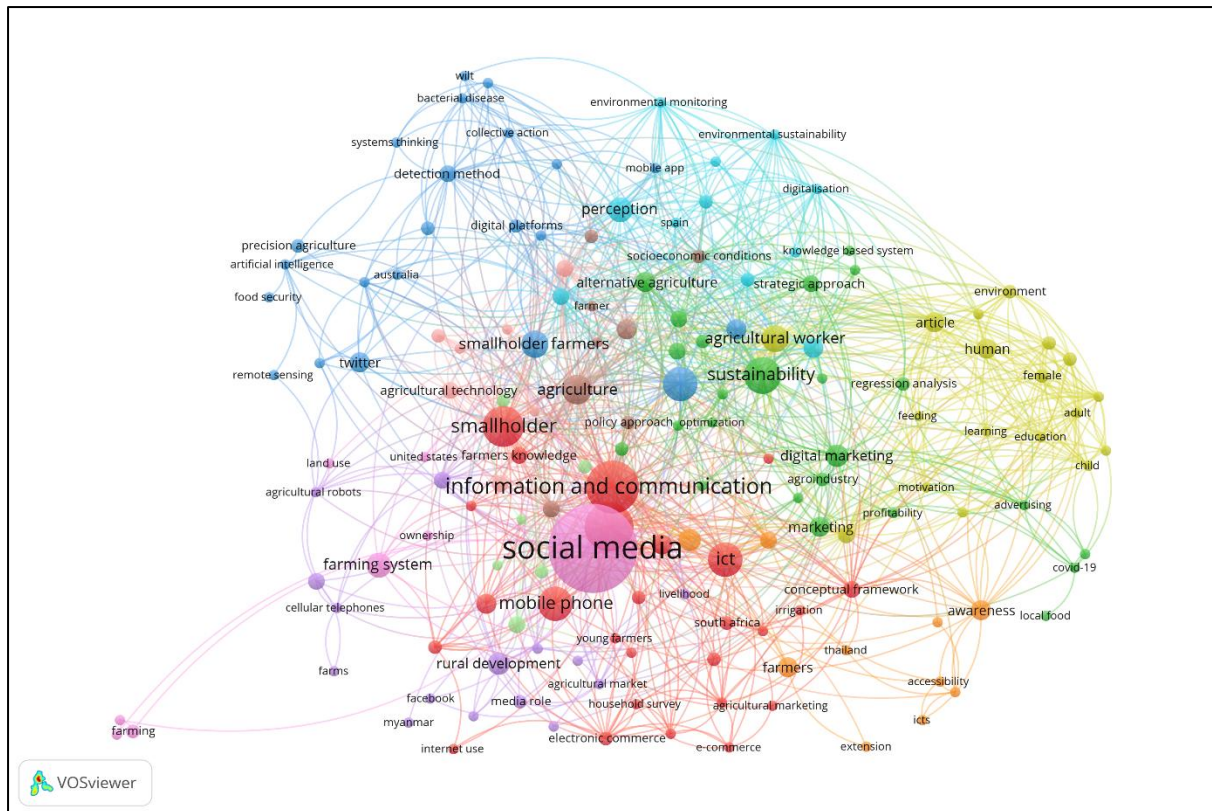


Fig. 2. Keyword Co-occurrence network map

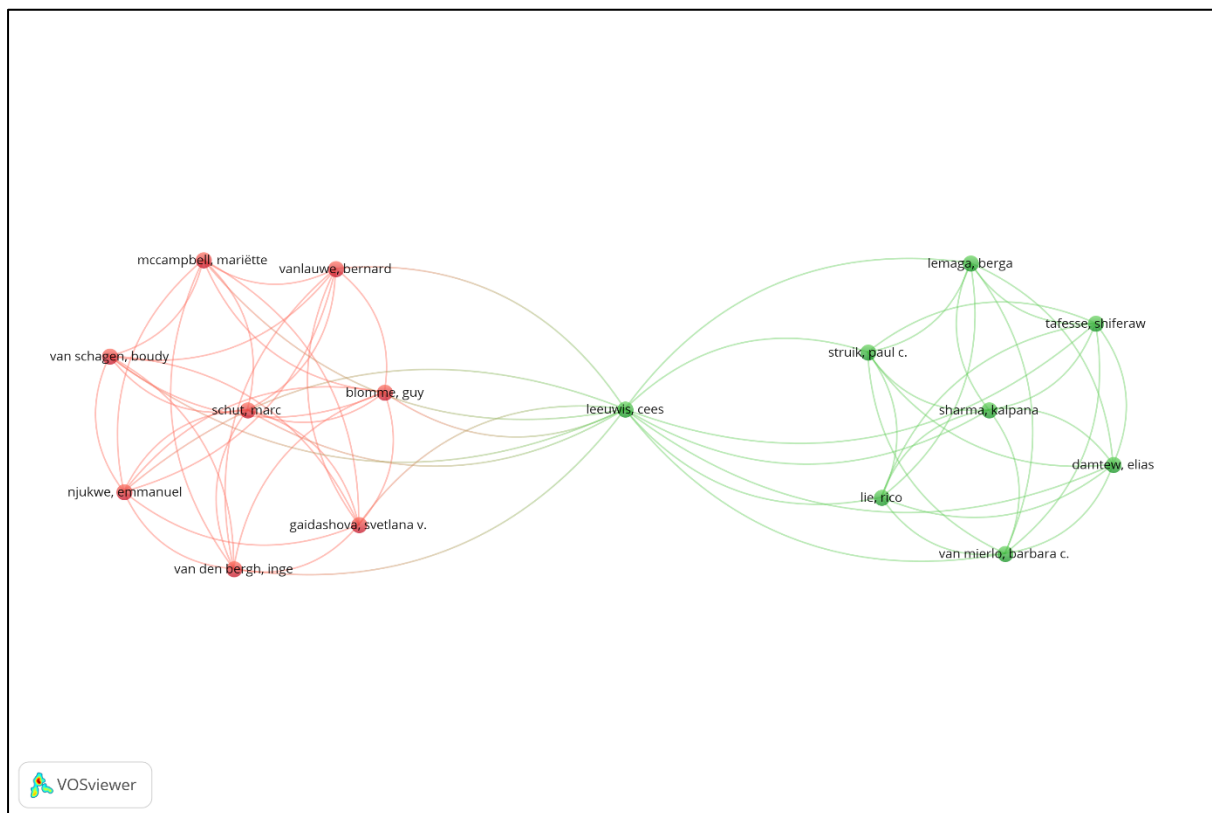


Fig. 3. Co-authorship network diagram

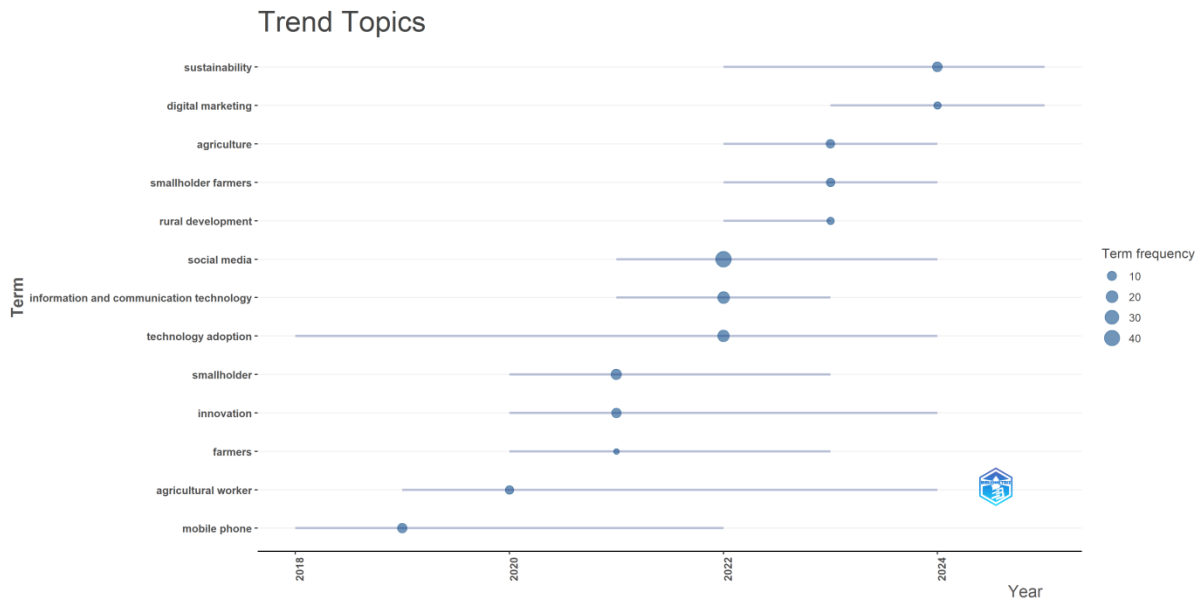


Fig. 4. Trend analysis of research themes

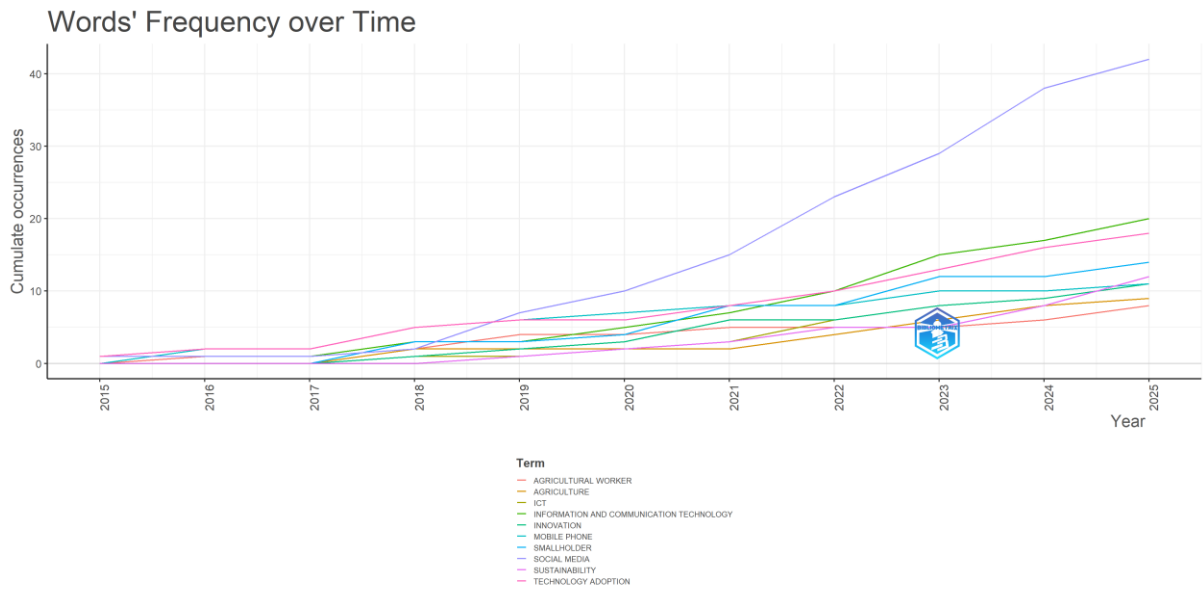


Fig. 5. Word frequency over time

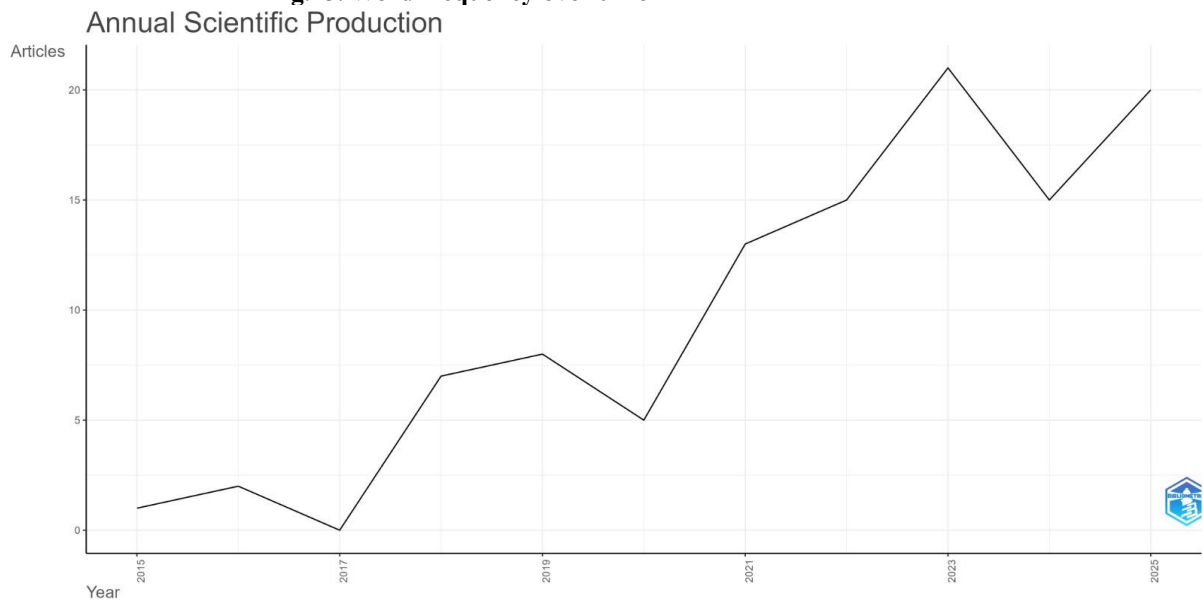


Fig. 6. Annual scientific production