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Digital Technologies in Agricultural Supply Chains in Central Africa: A Scoping Review of Equity, Resilience, and Adoption Barriers

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ABSTRACT

Digital technologies are increasingly reshaping agricultural supply chains by improving access to information, financial services, and markets. However, their role in fostering equity and resilience among smallholder farmers in Central Africa remains unclear. This scoping review examines the application of digital technologies in agricultural supply chains in the region and assesses their implications for these outcomes. Following the PRISMA extension for scoping reviews, a systematic search was conducted across Scopus, Web of Science, and Google Scholar for publications from 2015 to 2025 using keywords related to digital agriculture, agricultural supply chains, equity, resilience, and Central Africa. After removing duplicates, 139 unique records were screened. Of these, the 100 most relevant studies were assessed for full-text eligibility based on predefined inclusion criteria. Seven studies published between 2016 and 2024 were ultimately included in the analysis. The findings show that mobile-based technologies and communication platforms dominate digital agriculture initiatives in Central Africa. Key tools identified include SMS-based services, the e-Soko market pricing system, digital extension platforms such as CamAgro and the Twigire Muhinzi model, mobile financial services (mobile money), climate information services, and traditional communication channels such as radio, television, and mobile phones. These technologies improve farmers' access to market information, extension support, and climate-related knowledge. Yet adoption remains limited by weak digital infrastructure, low digital literacy, high costs, and persistent urban-rural digital divides. The review indicates that these accessible digital tools may contribute to greater equity and resilience in agricultural supply chains by enhancing information access, financial inclusion, and climate adaptation. Realising this potential will require substantial investments in rural digital infrastructure, targeted capacity-building programmes, and policies that address structural digital inequalities in Central African agricultural systems.

Keywords: digital agriculture, agricultural supply chains, equity, resilience, digital barriers

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1. INTRODUCTION

Digital transformation has become an important driver of agricultural development in the global economy, particularly in regions characterised by structural vulnerabilities such as Central Africa. Agriculture remains a key sector across African economies, employing a large share of the workforce and contributing significantly to national GDP (Abbasi et al., 2022). Despite its importance, the sector continues to face persistent structural challenges, including fragmented supply chains, limited market access, weak infrastructure, and increasing climate-related disruptions. These factors constrain productivity and threaten the long-term resilience and equitable development of agricultural systems in the region.

In recent years, digital innovations have been increasingly promoted as tools to address these challenges and improve the efficiency of agricultural supply chains. Technologies such as mobile platforms, artificial intelligence (AI), blockchain, the Internet of Things (IoT), and digital financial services have been identified as mechanisms to enhance transparency, offer reliable data management capabilities, improve information flows, and facilitate market access for farmers (Krishnan & Banga, 2020; Bahn et al., 2021; Bertalan et al., 2023). Studies also highlight the potential of digital technologies to strengthen adaptive capacity and support more resilient agri-food systems, particularly in contexts affected by climate variability, market volatility, and geopolitical disruptions (Anbumozhi et al., 2021; Belhadi et al., 2024; Gao & Gao, 2024).

Beyond productivity improvements, digitalisation is increasingly linked to broader development objectives, including fairness, equity, and inclusion within agricultural supply chains. Fairness refers to the just distribution of resources, opportunities, and benefits among supply chain actors. At the same time, equity emphasises the need to address structural disadvantages faced by specific groups such as smallholder farmers, women, and rural communities (Samoggia & Beyhan, 2022). Emerging technologies can support these goals by improving traceability, transparency, and access to information, thereby strengthening farmers' bargaining position and reducing information asymmetries in agricultural supply chains (Charlebois et al., 2024; Gikunda, 2024; Bertalan et al., 2024). In addition, evidence from short food supply chain initiatives, particularly community-supported agriculture, suggests that closer producer-consumer linkages can reduce information asymmetry and enhance transparency and fairness in agricultural supply chains (Kacz et al., 2019).

However, the benefits of digital transformation are not evenly distributed. A major challenge across many African countries is the persistent digital divide, reflected in unequal access to digital infrastructure, connectivity, devices, and digital skills (Abdulai, 2022; Mhlanga & Ndhlovu, 2023; Uyeh et al., 2023). In contexts where digital adoption remains uneven, technological innovation may unintentionally reinforce existing inequalities rather than reduce them. This issue is particularly relevant in Central Africa, where smallholder farmers and marginalised communities often face limited access to digital resources and institutional support (Nchofoung et al., 2022). Moreover, the increasing role of private-sector actors in digital agriculture raises concerns about governance, data ownership, and power asymmetries within agri-food systems (Arthur et al., 2024).

Resilience has therefore become a central concept in discussions of digital agricultural transformation. In agricultural supply chains, resilience refers to the capacity of systems and actors to anticipate, absorb, adapt to, and recover from shocks such as climate events, market disruptions, or pandemics. The COVID-19 pandemic highlighted the vulnerability of conventional agricultural supply chains and demonstrated the potential of digital technologies to maintain market connections, support farmer livelihoods, and facilitate information exchange during crises

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(Kumari et al., 2023; Njuguna et al., 2025; Tossou et al., 2024; Quayson & Osei, 2020). Nevertheless, resilience outcomes depend not only on technological availability but also on social, institutional, and governance factors that shape how digital tools are accessed and used (Vidanagamachchi et al., 2025; Xue et al., 2025).

Although a growing body of literature examines digital agriculture globally, relatively little research has explored how digital transformation interacts with equity and resilience in agricultural supply chains in Central Africa. Existing findings are often fragmented, focusing on specific technologies or individual countries rather than offering a comprehensive regional perspective. This gap limits policymakers' and researchers' ability to understand the broader implications of digitalisation for inclusive and resilient agricultural development in the region.

To address this gap, this study conducts a scoping review of digitalisation in agricultural supply chains in Central Africa. The review focuses on peer-reviewed studies published between 2015 and 2025, identified through systematic database searches. By synthesising the available literature, the study aims to examine how digital technologies are being applied within agricultural supply chains in the region and to assess their implications for equity and resilience among smallholder farmers. Specifically, it seeks to identify the digital tools applied, analyse the geographic distribution of existing studies, and assess how these technologies influence fair access to information, markets, and financial services. The review addresses the following research questions:

- What digital technologies are currently used in agricultural supply chains in Central Africa?
- How do these technologies contribute to equity and resilience among farmers?
- What barriers limit the adoption of digital agricultural technologies in the region?

2. METHODOLOGY

This study employed a scoping review methodology guided by the PRISMA extension for scoping reviews to systematically analyse the literature on digital transformation, equity, and resilience in Central African agriculture (Page et al., 2021; Tricco et al., 2018). A multidatabase search strategy was conducted across Scopus, Web of Science, and Google Scholar using a structured Boolean search that combined five thematic clusters: "digital agriculture", "agricultural supply chains", "equity" or "fairness", "resilience", and "Central Africa".

The search terms used in databases were: ("digital agriculture" OR "smart farming" OR "precision agriculture" OR ICT OR digitalisation) AND ("agricultural supply chain" OR "food supply chain" OR agribusiness) AND (equity OR fairness OR inclusion OR "social justice") AND (resilience OR "supply chain resilience") AND ("Central Africa" OR Cameroon OR Chad OR "Central African Republic" OR Congo OR Gabon OR Rawand).

The initial search identified 600 records. After removing 461 duplicate records, 139 unique studies were screened based on titles and abstracts (*Figure 1*). The 100 most relevant articles (as determined by the authors) were assessed for full-text eligibility using predefined inclusion criteria. Studies were included if they were published in English between 2015 and 2025, addressed digital technologies in agriculture, and examined equity, resilience, or adoption barriers within Central African contexts.

Following the screening process, seven studies met the final inclusion criteria and were retained for thematic analysis. Data extraction was conducted using Zotero and Microsoft Excel, enabling systematic coding of bibliographic information, technology categories, geographic focus, and adoption barriers, including equity and resilience dimensions (Brennan, 2016).

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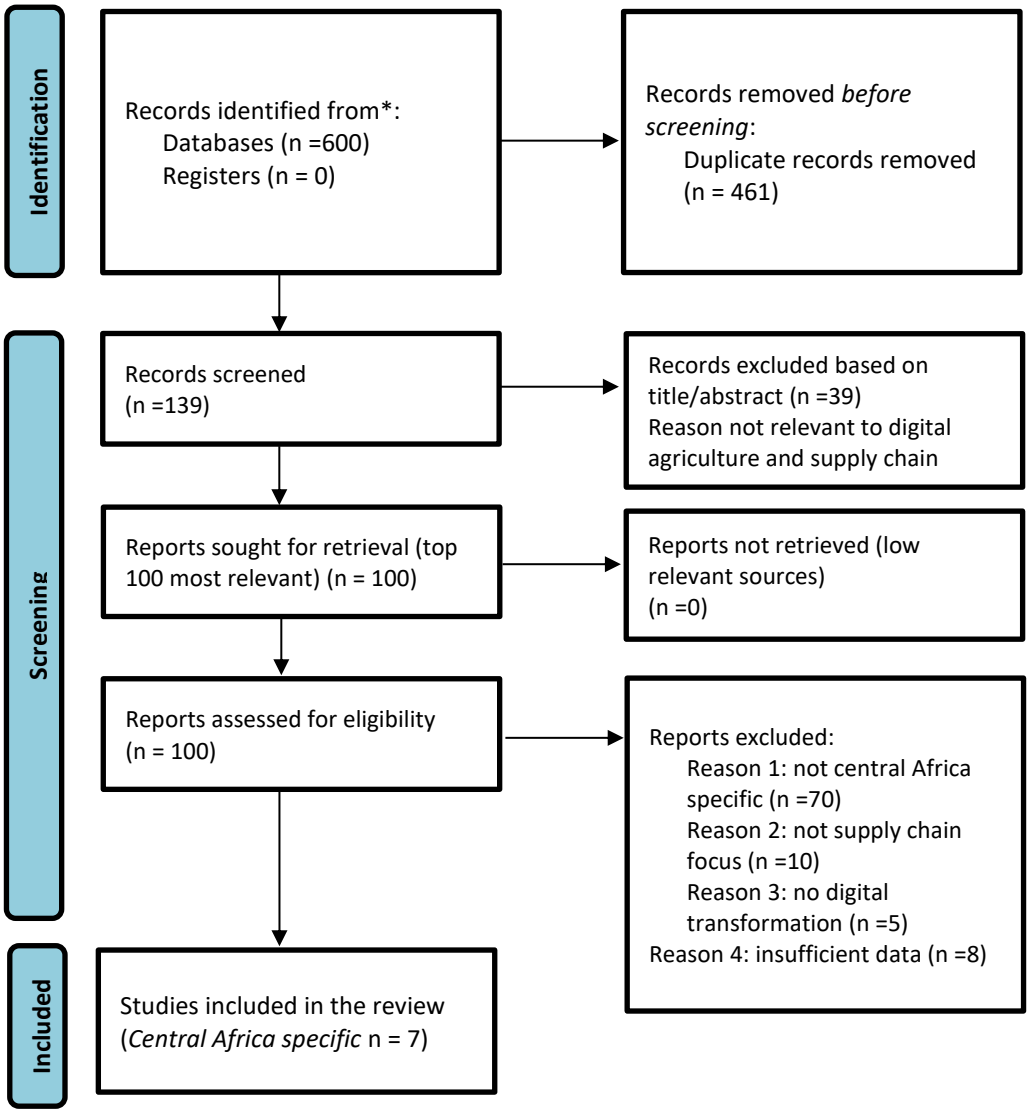

Figure 1: PRISMA flow diagram of the study selection process

Source: Adapted from Page et al. (2021).

3. RESULTS

3.1 Digital technologies and their contributions to equity and resilience in Central Africa

Table 1 presents the digital tools identified in the seven reviewed studies and their contributions to equity and resilience outcomes in agricultural supply chains in Central Africa. The results indicate that the technologies used in the region are primarily low-cost communication-based tools. These include digital platforms, mobile financial services, digital extension systems, radio and mobile phone communication technologies, climate information services, and SMS-based mobile platforms. These technologies play an important role in improving farmers' access to agricultural information, markets, and financial services, thereby supporting more equitable participation in agricultural systems. At the same time, several of these tools, particularly climate information

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services, digital extension services, and mobile market platforms, enhance farmers' capacity to respond to climate variability, market fluctuations, and production risks. The table suggests that the currently adopted technologies support information access, financial inclusion, and climate adaptation – key dimensions that may strengthen both equity and resilience in agricultural supply chains in Central Africa.

Table 1 also shows the publication years of the reviewed studies, indicating a gradual increase in research on digital technologies in agricultural systems over the past decade. The earliest study included in the review was published in 2016, followed by studies in 2017, 2019, 2021, 2022, and 2024. Although the search spanned 2015 to 2025, this pattern suggests growing academic and policy interest in the role of digital technologies for information dissemination, financial inclusion, and climate services.

In terms of geographic distribution, the studies are concentrated in a limited number of countries within Central Africa. Rwanda accounted for most of the identified studies, while only one study each was found for Cameroon and the Democratic Republic of Congo. Other countries in the Central African region, including Chad, the Central African Republic, Gabon, and Equatorial Guinea, were not represented in the reviewed literature (Manzoor & Wei, 2025). This uneven distribution, with five of the seven studies originating from Rwanda (often classified as East Africa), highlights a significant geographic research gap and indicates that empirical evidence on digitalisation in agricultural supply chains remains limited across much of Central Africa (see *Table 1*).

Table 1. Digital technologies and their contributions to equity and resilience in Central Africa

Author(s)	Year	Country	Technology category	Equity contributions	Resilience contributions
Mbairanodji et al.	(2024)	Cameroon	Digital platforms (CamAgro portal), decision support systems	Improves farmers' access to agricultural information, advisory services, and market linkages, supporting more inclusive participation in value chains.	Helps farmers make better production and management decisions through data and advisory tools, improving farm productivity and adaptive capacity.
Solo Zerbo & Pohl	(2022)	Democratic Republic of the Congo	Mobile financial services (mobile money)	Expands financial inclusion by enabling farmers to receive payments, transfer money, and access financial services without formal banking systems	Strengthens farmers' financial capacity to cope with shocks and invest in inputs, improving economic resilience
Neza et al.	(2021)	Rwanda	Digital extension services (Twigire Muhinzi model)	Enhances equitable access to agricultural knowledge through national extension	Builds farmers' technical skills and knowledge, improving their ability to respond

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				systems and farmer-to-farmer learning approaches	to climate and production risks
Nahayo et al.	(2019)	Rwanda	Communication tools (radio, television, mobile phones)	Provides low-cost, widely accessible channels for disseminating agricultural information to rural, low-literacy farmers	Delivers timely farming advice and climate information that supports adaptive decision-making
Clarkson et al.	(2017)	Rwanda	Climate information services (digital and mobile training)	Improves farmers' access to climate knowledge and agricultural advisory services	Helps farmers adjust planting schedules and crop management in response to climate forecasts, reducing climate-related risks.
Coulibaly et al.	(2017)	Rwanda	Climate information services (participatory digital tools, radio)	Encourages inclusive participation by integrating farmer knowledge with digital climate information systems	Supports collective learning and climate risk management strategies among farming communities
Nyasimi et al.	(2016)	Rwanda	Mobile platforms (SMS, e-Soko pricing system), radio	Improves market transparency by providing farmers with real-time price information and market access	Enables farmers to respond to market fluctuations and make informed selling decisions, strengthening livelihood stability

Source: The author

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3.2 Digital barriers to technology adoption in Central Africa

The reviewed studies highlighted several barriers to the adoption of digital technologies in agricultural supply chains across Central Africa, including limited digital and communication infrastructure in rural areas (Choruma et al., 2024). Many farming communities still face unreliable internet connectivity, weak mobile network coverage, limited access to electricity, and low digital literacy, all of which restrict the use of digital platforms and mobile-based services. These infrastructural challenges particularly affect remote rural farmers who rely heavily on basic communication tools such as radio and mobile phones to access agricultural extension services (Mbairanodji, 2024), as shown in *Figure 2*.

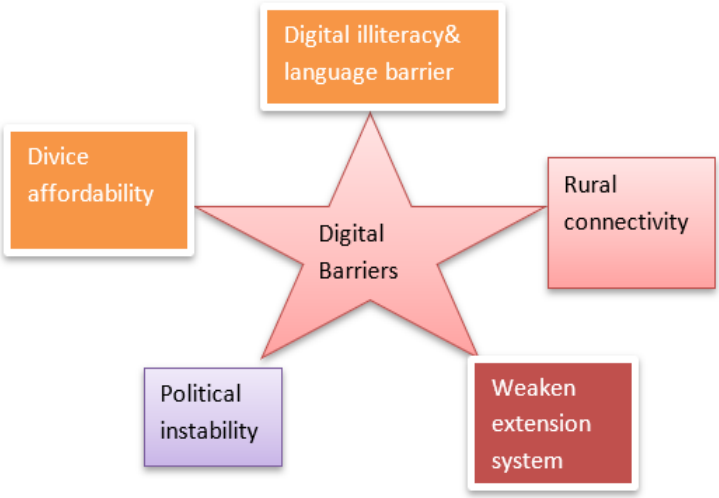

Figure 2. Barriers to the adoption of digital technologies in agricultural supply chains in Central Africa

Source: The author

4. DISCUSSION

4.1. Implications for equity and resilience in the agricultural supply chain in Central Africa

This review found that digital technologies may improve equity and resilience in agricultural supply chains in Central Africa. Mobile financial services and digital payment platforms appear to play a particularly important role in expanding financial inclusion for farmers with limited access to formal banking systems and in providing climate information. This finding is consistent with previous studies (Mwangakala et al., 2023; Nahayo et al., 2019; Ndhlovu, 2026; Nurudeen Michael & Eunice Ogunsola, 2023; Smidt & Jokonya, 2022). By facilitating access to extension services, savings mechanisms, and digital transactions, these tools allow farmers to optimise the use of agricultural inputs, manage financial risks, and stabilise their livelihoods more equitably.

Digital information platforms also contribute to resilience by improving farmers' access to timely information on weather conditions, market prices, and agricultural practices. This information can support better decision-making, improve climate adaptation strategies, and reduce the vulnerability of smallholder farmers to environmental and economic shocks (Apicella, 2025; Sun et al., 2026). In this way, digital technologies can strengthen the adaptive capacity of agricultural systems and improve the resilience of agricultural supply chains.

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These findings suggest that social and institutional factors strongly influence the relationship between digital agriculture and resilience. Trust networks, collective farmer organisations, and local governance structures can significantly affect the adoption and effective use of digital technologies (Razak et al., 2024; Zindi, 2026).

4.2 Technological patterns in digital agricultural supply chains in Central Africa

The results of this review indicate that the widespread use of mobile-based technologies and digital platforms primarily characterises digital agriculture in Central Africa. In contrast, more advanced technologies remain limited in their application. This pattern is also common in many other African contexts. The dominance of mobile solutions reflects the region's structural realities, where mobile phones are often the most accessible digital tools for farmers. Applications such as SMS-based advisory services, mobile money systems, and digital marketplaces play an important role in facilitating market access, improving price transparency, and enabling financial transactions within agricultural supply chains (Choruma et al., 2024).

The results further show that advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and blockchain are increasingly discussed in the literature; however, their practical implementation remains limited within the region. In many countries, these technologies are primarily applied in experimental projects, pilot programmes, or research initiatives rather than being widely integrated into everyday farming practices (Apicella, 2025; Fernando et al., 2024; Yuan et al., 2025). As mentioned in the previous section, this pattern of digital technology use in Central Africa reflects the infrastructural and institutional barriers identified in the results, including limited digital infrastructure, technical capacity, and financial resources. Bridging this technological gap may require targeted investments in digital infrastructure, training, and institutional support systems that enable smallholder farmers to access and effectively utilise advanced technologies.

4.3 Structural barriers to digital adoption in Central Africa

The synthesis of the reviewed studies identifies several interconnected barriers that continue to limit the expansion of digital agriculture in Central Africa. These barriers operate across infrastructural, economic, institutional, and human capacity dimensions (Mazwane et al., 2022; Mhlanga & Ndhlovu, 2023; Smidt & Jokonya, 2022). Infrastructure limitations remain one of the most significant challenges. Many rural areas in Central Africa continue to experience unreliable internet connectivity, limited electricity supply, and inadequate telecommunications infrastructure. These structural constraints significantly restrict farmers' ability to access and utilise digital agricultural services.

Human capacity constraints represent another major barrier. The results emphasised that farmers lack the digital skills required to navigate digital platforms effectively. Low levels of digital literacy, limited access to training opportunities, and language barriers further reduce farmers' ability to engage with digital technologies; this finding aligns with that of Mazwane et al. (2024).

Economic factors also play a critical role. The cost of smartphones, internet data packages, and subscription-based digital services can be a huge burden for smallholder farmers with limited financial resources (Choruma et al., 2024). As a result, even where digital tools are technically available, affordability remains a key determinant of adoption. Consequently, these findings suggest the need to develop and integrate strategies that combine technological innovation with investments in infrastructure, capacity building, and inclusive policy frameworks.

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5. LIMITATIONS, RESEARCH GAPS, AND DIRECTIONS FOR FUTURE RESEARCH

The review is limited by the lack of information on the digital regulatory framework and issues of digital scalability in Central African countries (Arangurí et al., 2025; Das & Kamal, 2025; McFadden et al., 2022). The use of more standardised evaluation frameworks in future studies would improve the comparability and reliability of research in this area. A significant research gap exists in the geographic coverage of the literature. Empirical studies focusing specifically on Central Africa remain scarce. Although the present review included studies from the region, most are from Rwanda. Most research on digital agriculture in Africa has focused on other regions, particularly East Africa (Hackfort, 2021; Manzoor & Wei, 2025; Porciello et al., 2022). As a result, there is limited evidence on how digital technologies function within the specific institutional, infrastructural, and socio-economic conditions of Central African countries. Further research is needed to determine whether early adoption leads to sustainable digital use and long-term improvements in farmers' livelihoods and supply chain performance.

6. CONCLUSION

The main goal of the current review was to explore the role of digital technologies in agricultural supply chains in Central Africa, with a particular focus on their contributions to equity and resilience. The study followed the PRISMA extension for scoping reviews to identify relevant peer-reviewed articles. The findings showed that accessible, low-cost technologies largely shape the digital landscape in Central Africa, particularly Rwanda. Tools such as digital platforms (e.g., the CamAgro portal), mobile financial services, digital extension systems, communication technologies (including radio and mobile phones), climate information services, and SMS-based market platforms (e.g., e-Soko) were the most used technologies identified in the reviewed studies. These technologies support information dissemination, market access, financial transactions, and farmer training.

The evidence suggests that these technologies have the potential to enhance equity and fairness within agricultural supply chains by improving farmers' access to markets, financial services, and agricultural knowledge (Nchofoung et al., 2022). Mobile financial services and digital extension platforms contribute to more inclusive participation by enabling smallholder farmers, women, and rural communities to access resources that were previously difficult to obtain. In addition, climate information services and communication technologies strengthen farmers' adaptive capacity, thereby supporting resilience to climate variability and market shocks (Nahayo et al., 2019).

However, the findings also reveal that the benefits of digitalisation are unevenly distributed. Persistent digital divides—driven by limited infrastructure, low digital literacy, and economic constraints—continue to act as barriers to access to digital technology for many smallholder farmers in Central Africa (Yousif et al., 2025). Addressing these structural barriers through targeted investments in infrastructure, capacity-building, and inclusive digital policy frameworks is an important component of ensuring that digital transformation contributes to more sustainable, equitable, and resilient agricultural practices in Central Africa (Vuvor et al., 2025).

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Digitális technológiák a közép-afrikai mezőgazdasági ellátási láncokban: átfogó szakirodalom-áttekintés a méltányosságról, a rezilienciáról és a bevezetést gátló tényezőkről

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ÖSSZEFOGLALÁS

A digitális technológiák egyre inkább átalakítják a mezőgazdasági ellátási láncokat az információhoz, a pénzügyi szolgáltatásokhoz és a piacokhoz való hozzáférés javításával. Ugyanakkor az egyenlőség és a reziliencia előmozdításában játszott szerepük a kisbirtokos gazdálkodók körében Közép-Afrikában továbbra is tisztázatlan. Az átfogó szakirodalmi áttekintés vizsgálja a digitális technológiák alkalmazását a mezőgazdasági ellátási láncokban a régióban, és értékeli ezeknek az eredményeknek a következményeit. Az átfogó szakirodalmi áttekintés PRISMA kiterjesztését követve szisztematikus keresés zajlott a Scopus, a Web of Science és a Google Scholar adatbázisokban 2015 és 2025 közötti publikációkra, a digitális mezőgazdaság, mezőgazdasági ellátási láncok, egyenlőség, reziliencia és Közép-Afrika kulcsszavak használatával. A duplikátumok eltávolítása után 139 egyedi rekord került leszűrésre. Ezek közül a 100 legrelevánsabb tanulmányt teljes szöveges értékelésre jelöltük ki, előre meghatározott befogadási kritériumok alapján. Végül hét, 2016 és 2024 között megjelent tanulmány került bevonásra az elemzésbe. Az eredmények azt mutatják, hogy a mobilalapú technológiák és kommunikációs platformok dominálják a digitális mezőgazdasági kezdeményezéseket Közép-Afrikában. A legfontosabb azonosított eszközök közé tartoznak az SMS-alapú szolgáltatások, az e-Soko piaci árképző rendszer, a CamAgro és a Twigire Muhinzi modellhez hasonló digitális kiterjesztési platformok, a mobil pénzügyi szolgáltatások (mobilpénz), az éghajlati információs szolgáltatások, valamint a hagyományos kommunikációs csatornák, mint a rádió, a televízió és a mobiltelefonok. Ezek a technológiák javítják a gazdálkodók hozzáférését a piaci információkhoz, a kiterjesztési támogatáshoz és az éghajlattal kapcsolatos ismeretekhez. Az adoptációt azonban továbbra is korlátozza a gyenge digitális infrastruktúra, az alacsony digitális írástudás, a magas költségek és a városi-vidéki digitális szakadékok. Az elemzés szerint ezek az elérhető digitális eszközök hozzájárulhatnak az egyenlőség és a reziliencia növekedéséhez a mezőgazdasági ellátási láncokban az információhoz való hozzáférés, a pénzügyi befogadás és az éghajlati alkalmazkodás javításával. E potenciál kihasználásához jelentős beruházások szükségesek a vidéki digitális infrastruktúrába, célzott kapacitásépítő programokba, valamint olyan politikákba, amelyek kezelik a digitális egyenlőtlenségeket a közép-afrikai mezőgazdasági rendszerekben.

Kulcsszavak: digitális mezőgazdaság, mezőgazdasági ellátási láncok, egyenlőség, reziliencia, adaptációs akadályok

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