

# Digital Marketplaces and E-Commerce Platforms for Rural Farmers in Limpopo Province, South Africa: Transforming Agricultural Value Chains and Rural Entrepreneurship

Mantlo Richard Ngwepe<sup>\*</sup>, Humphrey Lephetha Motsepe<sup>\*\*</sup>

ARTICLE INFO	ABSTRACT
<p><i>Article history:</i>                      Received: April 09, 2026                      Accepted: June 26, 2026                      Published: June 30, 2026</p>	<p>Digital technologies are on the trajectory of reshaping agricultural markets and rural economic systems across developing regions. This article examines how digital marketplaces and e-commerce platforms influence income generation, agricultural value chains, and entrepreneurship among rural farmers in Limpopo Province, South Africa. The study employs a systematic literature review methodology to synthesise recent scholarly and institutional literature on digital agriculture, rural digital markets, and e-commerce adoption among smallholder farmers. Academic databases including Scopus, Web of Science, and Google Scholar were used to identify relevant publications produced between the year 2020 to the most recent publications of 2026. The findings indicate that digital marketplaces allow farmers to reach wider consumer markets, lessen their reliance on intermediaries, and enhance price transparency and profitability for primary producers. Evidence also shows that e-commerce platforms enhance value chain coordination and support the emergence of rural agricultural entrepreneurship. However, persistent challenges remain, including digital literacy gaps, infrastructure limitations, and unequal access to internet connectivity. The article contributes to the growing body of research on digital transformation in agriculture by highlighting the opportunities and structural barriers associated with rural digital commerce. The findings suggest that targeted policy interventions, digital infrastructure investment, and capacity development programmes are necessary to maximise the benefits of digital marketplaces for smallholder farmers in Limpopo and other rural regions.</p>
<p><i>JEL Classification:</i>                      Q1, Q19</p> <p><i>Keywords:</i>                      Agricultural Value Chains; Digital Agriculture; E-commerce; Rural Entrepreneurship; Smallholder Farmers</p>	

*Journal of Agriculture and Rural Development Studies (JARDS)* © 2026 is licensed under [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/).

## 1. Introduction

Agriculture remains a fundamental pillar of rural livelihoods across many developing economies, particularly within Sub-Saharan Africa, where smallholder farmers play a crucial role in food production, employment generation, and local economic development. These farmers form the backbone of national food security, yet structural and systemic barriers frequently limit their participation in formal agricultural markets and reduce potential profitability of their production. Challenges related to lack or underdeveloped infrastructure, limited access to market information, and the predominance of

<sup>\*</sup>, <sup>\*\*</sup> Limpopo Department of Agriculture and Rural Development, Crop Science Directorate, Towoomba Research Centre, Bela Bela, South Africa. Email addresses: [ngwepem@gmail.com](mailto:ngwepem@gmail.com) (Corresponding author - M. R. Ngwepe), [hlmotsepe@gmail.com](mailto:hlmotsepe@gmail.com). (H. L. Motsepe).

intermediaries often constrain the ability of smallholders to negotiate fair prices, access to buyers, or to be integrated effectively into value chains (Food and Agriculture Organization [FAO], 2022; World Bank, 2021). Traditional marketing mechanisms in rural contexts are typically informal, fragmented, and dominated by a few powerful intermediaries, which creates inefficiencies and limits income opportunities for these producers. As a result, many smallholder farmers remain locked in low-margin systems despite their critical contribution to food security and rural economies. The expansion of digital technologies offers new potential avenues to overcome several of these challenges by transforming the way agricultural markets operate. The current industrial revolution, digital marketplaces and e-commerce platforms increasingly allow farmers to interact directly with consumers, retailers, and agribusiness firms, bypassing traditional intermediaries and improving the efficiency of transactions at minimal costs. These platforms enable farmers to advertise products online, negotiate prices, coordinate delivery logistics, and receive digital payments securely, effectively reducing transaction costs and improving market transparency and profitability of the products (African Union [AU], 2024; World Bank, 2025a).

Digital solutions also provide access to real-time market data, enhancing decision-making related to crop selection, pricing, and the timing of sales, and enabling smallholders to respond more effectively to market demand and consumer preferences (Aker & Fafchamps, 2015; Manzoor et al., 2025). In South Africa, digital transformation in agriculture has gained increasing attention from policymakers seeking to boost rural economic development. Provinces such as Limpopo, home to a substantial population of smallholder farmers, illustrate both the opportunities and challenges inherent in digital agricultural adoption. Despite the significant contribution of these farmers to local food production, many still rely on informal marketing networks that offer limited bargaining power for their produce which is constantly exposed to price volatility (Morepje et al., 2024; Nxumalo & Chauke, 2025). The growth of digital marketplaces presents an opportunity to enhance income generation and increasing profit margins, strengthen agricultural value chains, and stimulate rural entrepreneurship (Baumüller et al., 2023). This potential is particularly evident in value addition initiatives within Limpopo Province, where agro-processing activities such as mango value addition demonstrate promising economic viability for rural development and smallholder empowerment (Ngwepe & Motsepe, 2026). Evidence from recent studies highlights the potential of digital platforms to improve smallholder productivity and market participation. Aker & Fafchamps (2015) demonstrate that mobile-based agricultural platforms significantly reduce information asymmetries, enabling farmers to access more accurate and timely pricing data while lowering transactional costs. Similarly, Baumüller et al. (2023) emphasize that digital tools help integrate smallholders into regional and international value chains by facilitating communication, coordination, and social capital development within agricultural networks. Chandra & Collis (2021) further note that digital technologies can broaden market access, support more efficient production-to-market linkages, and foster confidence and entrepreneurial behaviour among rural producers. At the same time, challenges to adoption persist coupled with insufficient internet connectivity, limited digital literacy, and institutional barriers that hinder full utilization of these technologies (Gumbi et al., 2023; Manzoor et al., 2025). Without policy interventions to address these constraints, the benefits of digital agriculture risk being unevenly distributed, reinforcing existing inequalities between well-resourced and resource-constrained farmers (Mehrabi et al., 2021; World Bank, 2025c).

This study examines how digital marketplaces and e-commerce platforms are reshaping rural agricultural economies in Limpopo Province. It situates the discussion within the broader literature on digital agriculture, synthesizing evidence on the opportunities and challenges associated with digital commerce for income generation, value chain restructuring, and entrepreneurship among smallholder farmers (Birner et al., 2021; Morepje et al., 2024). By focusing on Limpopo, the study highlights both the practical implications of digital adoption and the structural factors that shape the effectiveness of digital agricultural interventions in rural South African contexts. The objectives of the study are threefold:

- ✧ First, it explores how digital marketplaces influence income generation among smallholder farmers by broadening access to the markets, improving price transparency, and reducing dependence on intermediaries.
- ✧ Second, it examines the role of e-commerce platforms in restructuring agricultural value chains, including coordination among producers, processors, and retailers, and the integration of traceability and quality assurance mechanisms.
- ✧ Third, it analyses how digital platforms support the development of rural agricultural entrepreneurship, enabling farmers to adopt innovative marketing strategies, value-added processing, and cooperative business models that enhance economic resilience and profitability.

Guided by these objectives, the study addresses the following research questions:

- ✧ How do digital marketplaces affect income generation among rural farmers in Limpopo?
- ✧ In what ways do e-commerce platforms reshape agricultural value chains in rural farming communities? And
- ✧ How do digital platforms contribute to the growth of agricultural entrepreneurship among smallholder farmers?

In relation to addressing these questions, the study contributes to policy-relevant insights on the design and implementation of digital agricultural initiatives and provides evidence for strategies aimed at creating an inclusive rural development and smallholder empowerment.

## 2. Literature review

### 2.1 Digital Marketplaces and Agricultural Market Access

Digital marketplaces are currently transforming agricultural market access by enabling farmers to interact directly with buyers through online platforms that facilitate product listing, price negotiation, and ease of processing payment. These platforms reduce transactional costs and enhance price transparency by providing real-time market information, allowing farmers to make more informed decisions about when and where to sell their produce (Aker & Fafchamps, 2015; Morepje et al., 2024). By connecting smallholder producers to multiple buyers simultaneously, digital marketplaces diminish the dependence on intermediaries who traditionally control pricing and distribution channels, thereby increasing farmers' bargaining power and the potential for higher profit margins or earnings (Fabregas, Kremer, & Schilbach, 2022; World Bank, 2025b). The income benefits associated with digital

marketplaces are significant. Farmers using these platforms often obtain more competitive prices for their produce, as they can reach a broader network of consumers, retailers, and institutional buyers. These platforms enormously widen and expand market access and helps stabilize demand and reduces the uncertainty that smallholder farmers face when relying solely on local and informal markets (FAO, 2022; Gumbi et al., 2023). Digital marketplaces also improve access to market intelligence, including information on commodity prices, demand trends, and logistics options, which further supports strategic decision-making and resource allocation (Manzoor et al., 2025). These platforms, therefore, act as both market facilitators and informational hubs, providing a foundation for more efficient and profitable farming operations. In addition to economic benefits, digital agriculture initiatives foster greater integration of farmers into broader digital ecosystems.

Across Africa, over 400 digital agriculture services are operational, encompassing mobile-based market platforms, digital financial solutions, and extension services that guide agricultural practices (FAO, 2022). These platforms often link agricultural production, marketing, and financial services, enabling smallholder farmers to manage sales, payments, and production inputs more effectively. By centralizing these functions within digital systems, farmers can reduce operational inefficiencies and better coordinate their activities across the agricultural value chain (Gumbi et al., 2023; Manzoor et al., 2025). While these platforms improve access to buyers and facilitate direct sales, their effectiveness depends on the availability of supporting infrastructure, such as reliable internet connectivity and sufficient mobile network coverage, which remains uneven across regions (Aker & Fafchamps, 2015). Farmers in remote or rural areas may face barriers to adoption due to limited digital literacy or insufficient access to devices, constraining the reach and impact of digital marketplaces.

In summary, addressing these structural constraints is essential to ensure that the benefits of digital agriculture are equitably distributed among smallholder farmers (FAO, 2022; Morepje et al., 2024). By providing platforms for direct interaction with multiple buyers, they reduce the reliance on multiple intermediaries, which historically has fragmented value chains and suppressed prices for producers. The extent of these benefits, however, is contingent on access to digital infrastructure, connectivity, and training, highlighting the need for complementary policy measures that support rural digital inclusion (Aker & Fafchamps, 2015; Gumbi et al., 2023; Morepje et al., 2024).

## **2.2 E-Commerce Platforms and Agricultural Value Chains**

Agricultural value chains encompass a series of interconnected activities that move products from production to consumption, traditionally involving multiple intermediaries. This structure increases transactional costs and reduces profit margins for smallholder farmers whilst limiting their ability to capture the full value of their produce (Birner et al., 2021). By facilitating direct interactions among producers, processors, distributors, and retailers, digital platforms reduce reliance on intermediaries and allow farmers to negotiate better prices and access broader markets (Baumüller et al., 2023). E-commerce platforms enhance value chain transparency by providing digital records of transactions, inventory, and product movement. This increased visibility strengthens trust among value chain actors, as buyers can verify product origin, quality, and production practices, while farmers gain access to real-time market data that informs pricing and sales decisions (Schroeder et al., 2021; World Bank, 2021). The integration of traceability mechanisms is particularly important for higher-value and export-oriented markets, which often require detailed documentation of production standards and compliance

with safety regulations. By enabling participation in these markets, digital platforms expand income opportunities and encourage farmers to adopt improved production practices, including agro-processing and value addition initiatives such as mango processing in Limpopo Province (Ngwepe & Motsepe, 2026).

Logistics coordination is another critical dimension of e-commerce-enabled value chains. Digital platforms can connect farmers to transportation services, warehouses, and distribution networks, facilitating the movement of products from rural production areas to urban, regional or overseas markets. The combination of digital coordination and real-time information flow allows farmers and other actors to align production and distribution with market demand, reduces post-harvest losses, minimizes delays, and lowers the cost of delivery, thereby improving the overall efficiency and profitability of agricultural value chains (World Bank, 2021; Baumüller et al., 2023), whilst increasing the predictability of supply. These capabilities not only enhance farmers' income potential but also contribute to more competitive and resilient agricultural markets by promoting efficient allocation of resources across the value chain. Through coordinated digital marketing, farmers can reach niche markets more effectively, creating opportunities for brand development and differentiation that were previously unavailable in traditional local markets. This technological integration encourages farmers to adopt better agronomic practices, as digital monitoring links production methods directly to market access and premium pricing opportunities, reinforcing positive feedback between quality, trust, and income generation whilst building more confidence for future production. The cumulative effect of e-commerce adoption is a transformation in the structure of agricultural value chains. Digital platforms reduce fragmentation, enhance coordination, and strengthen linkages between producers and consumers, creating more efficient, transparent, and equitable markets. By enabling direct communication, integrating logistics, and improving access to market intelligence, these platforms empower farmers to participate more fully in value creation and capture a quantum share of economic benefits of their production (World Bank, 2021; Fabregas et al., 2022; Baumüller et al., 2023). Despite these advantages, the impact of e-commerce platforms depends on access to digital infrastructure, internet connectivity, and technological literacy. Regions with limited network coverage or low digital adoption may experience slower integration into digital value chains, highlighting the need for policy interventions and support programs that address these barriers (Manzoor et al., 2025). In summary, e-commerce platforms are reshaping agricultural value chains by enhancing transparency, coordination, and efficiency. By reducing intermediary dependence, improving logistics, supporting traceability, and enabling collective marketing, farmers can capture greater value from their production and participate in higher-value markets.

### **2.3 Digital Technologies and Rural Agricultural Entrepreneurship**

Digital platforms have emerged as critical tools for fostering rural agricultural entrepreneurship by enabling farmers to access broader markets, diversify income streams, and develop innovative business models. These platforms are aimed at eliminating dependence on traditional intermediaries, allowing producers to negotiate directly with buyers, improve pricing transparency, and align production with market demand, which collectively enhances income potential and business resilience (Aker & Fafchamps, 2015; Fabregas et al., 2022). Digital tools enable farmers to transition from purely production-focused roles to entrepreneurial actors who actively manage branding, product

differentiation, and customer engagement. For example, platforms facilitate online marketing by providing functionalities such as product listings, imagery, reviews, and digital payment systems, all of which contribute to stronger relationships with consumers and increased visibility for individual farmers or cooperative groups (Bontsa et al., 2023; Morepje et al., 2024). In addition to market access and business development, digital platforms encourage cooperative and networked entrepreneurship. Farmers can form digital associations or cooperatives that pool resources, coordinate production schedules, and collectively market produce to institutional buyers, urban consumers, or niche segments. These cooperative models strengthen bargaining power, stabilize supply, and allow smallholders to overcome the limitations of fragmented production systems (Baumüller et al., 2023; Manzoor et al., 2025).

Despite these opportunities, structural and technological barriers limit the widespread adoption of digital tools among rural farmers. Limited internet connectivity, inadequate mobile coverage, and high infrastructure costs constrain the ability of resource-poor communities to fully exploit and participate in digital agricultural markets (Aker & Fafchamps, 2015; Nxumalo & Chauke, 2025). Moreover, digital literacy remains a critical constraint, as farmers often lack the skills necessary to navigate online marketplaces, engage in digital marketing, or leverage e-commerce functionalities effectively (Bontsa et al., 2023; Manzoor et al., 2025). Without targeted interventions, these barriers risk reinforcing existing inequalities between technologically advanced producers and those operating under resource constraints, potentially excluding marginalized groups from the benefits of digital entrepreneurship (Mehrabi et al., 2021; World Bank, 2025a).

Digital platforms also facilitate financial innovation in rural agricultural entrepreneurship. Access to digital financial services further enables farmers to invest in value-added processing, marketing initiatives, and production improvements, thereby reinforcing entrepreneurial activity and increasing the resilience of farm businesses (World Bank, 2021; FAO, 2022). When combined with analytics and market intelligence provided by these platforms, farmers can make data-driven decisions regarding pricing, production volume, and diversification strategies, further improving the efficiency and profitability of their enterprises (Fabregas et al., 2022; Manzoor et al., 2025). Platforms that support traceability, quality assurance, and product branding encourage adherence to higher production standards, indirectly fostering sustainable agricultural practices and market-oriented innovation. Over time, these dynamics contribute to more robust, competitive, and resilient rural agricultural systems capable of adapting to market shifts and global demand trends (Rose & Chilvers, 2018; Schroeder et al., 2021).

Nonetheless, the literature emphasizes that the success of digital agricultural entrepreneurship is contingent on equitable access and contextual adaptation. Interventions must consider local socio-economic conditions, infrastructure constraints, and cultural factors influencing adoption (Mehrabi et al., 2021; Nxumalo & Chauke, 2025). In a nutshell, digital technologies are transforming rural agricultural entrepreneurship by enabling market access, promoting value-added activities, and fostering cooperative and networked business models. These platforms empower farmers to adopt entrepreneurial roles, enhance profitability, and engage higher-value markets, while simultaneously facilitating knowledge exchange and financial inclusion.

## 2.4 Synthesis of Reviewed Studies on Digital Agriculture

The reviewed literature demonstrates a broad consensus regarding the transformative potential of digital technologies in agriculture. Table 1 below provides synthesis of reviewed studies on digital agriculture.

**Table 1. Synthesis of Key Studies on Digital Marketplaces, Value Chains, and Rural Entrepreneurship**

Author(s) and Year	Focus Area	Methodology	Key Findings	Limitations	Relevance to the Study
Aker & Fafchamps (2015)	Mobile technologies and market access	Empirical analysis	Improved price transparency and reduced transaction costs through mobile connectivity	Focuses on mobile phones rather than comprehensive digital platforms	Demonstrates the role of digital tools in enhancing market efficiency for smallholders
Fabregas et al. (2022)	Digital agricultural advisory services	Experimental and policy analysis	Digital platforms reduce information asymmetry and improve decision-making	Emphasis on advisory services rather than market platforms	Supports the role of digital technologies in enhancing farmer productivity and income
Food and Agriculture Organization (2022)	Digital agriculture and automation	Global policy analysis	Digital tools transform agrifood systems and promote financial inclusion	Broad global perspective with limited regional specificity	Provides a foundational framework for digital agriculture adoption
Baumüller et al. (2023)	ICTs in agricultural value chains	Mixed-methods study	Digital platforms strengthen market linkages and social capital	Focused on African contexts with varied technological environments	Demonstrates the integration of smallholders into value chains
Morepje et al. (2024)	E-commerce and sustainable agriculture	Quantitative study	Digital platforms enhance market participation and sustainability	Limited focus on entrepreneurship outcomes	Highlights the impact of e-commerce on smallholder development
Manzoor et al. (2025)	Digital agriculture adoption in developing countries	Systematic literature review	Adoption improves productivity but is constrained by infrastructure and skills	Generalised findings across multiple regions	Identifies barriers affecting rural digital transformation
Nxumalo & Chauke (2025)	Digital agriculture in South Africa	Empirical regional study	Infrastructure and digital literacy remain major adoption constraints	Focused on South African smallholders	Provides contextual relevance to Limpopo Province

Author(s) and Year	Focus Area	Methodology	Key Findings	Limitations	Relevance to the Study
Birner et al. (2021)	Digital transformation in agriculture	Literature review	Digitalisation enhances efficiency and innovation in value chains	Primarily supply-side oriented	Explains structural shifts in agricultural markets
Schroeder et al. (2021)	Digital transformation of agrifood systems	World Bank report	Digital technologies strengthen transparency and traceability	Policy-oriented analysis	Supports the role of digital technologies in modern value chains
Ngwepe & Motsepe (2026)	Value addition in Limpopo	Empirical case study	Agro-processing enhances rural economic viability and income diversification	Commodity-specific focus on mango value chains	Provides localized evidence relevant to entrepreneurship and value addition
Gwelo (2025)	Digital knowledge dissemination	Scholarly analysis	Social media democratizes agricultural knowledge and innovation	Emerging research area	Demonstrates the role of digital tools in fostering entrepreneurship
Rose & Chilvers (2018)	Agriculture 4.0 and innovation	Conceptual study	Digitalisation drives responsible and inclusive agricultural innovation	Largely theoretical	Provides a theoretical foundation for digital entrepreneurship

*Source: information was sourced from listed of authors found in collum one of the table 1 above.*

Studies by Aker and Fafchamps (2015) and Fabregas et al. (2022) establish that digital platforms improve price transparency, reduce information asymmetries, and enhance farmers' access to markets. However, these studies primarily emphasize efficiency gains and provide limited insights into broader socio-economic impacts, particularly within localized rural contexts. Similarly, global policy reports such as those by the Food and Agriculture Organization (2022) and the World Bank (2021) highlight the transformative role of digital technologies in modernizing agrifood systems. While these sources offer valuable strategic insights, their macro-level orientation often overlooks micro-level realities experienced by smallholder farmers in specific regions such as Limpopo Province. This limitation underscores the importance of context-specific research to bridge global frameworks with local realities. Research focusing on African agricultural systems, including Baumüller et al. (2023) and Morepje et al. (2024), provides empirical evidence of the positive impacts of digital platforms on value chains and sustainability. These studies demonstrate that digital technologies enhance coordination, strengthen market linkages, and improve farmers' access to information. Nevertheless, they also reveal persistent disparities in technological adoption due to infrastructural deficiencies and socio-economic constraints. South African studies, particularly Nxumalo and Chauke (2025), offer valuable regional insights by identifying challenges such as inadequate digital infrastructure, limited connectivity, and

insufficient digital literacy. These findings align with the broader observations of Manzoor et al. (2025), who emphasize that technological adoption in developing countries remains uneven. Together, these studies highlight the structural barriers that must be addressed to ensure inclusive digital transformation.

The literature on digital entrepreneurship further illustrates the evolving role of farmers as agribusiness actors. Rose and Chilvers (2018) and Gwelo (2025) argue that digital technologies enable innovation, knowledge sharing, and market participation. However, these conceptual perspectives require empirical validation within specific rural contexts. The work of Ngwepe and Motsepe (2026) addresses this gap by demonstrating the economic viability of agro-processing initiatives in Limpopo Province, thereby providing localized evidence of how value addition can enhance rural entrepreneurship. In spite of the breadth of existing scholarship, notable gaps remain. First, many studies adopt a descriptive rather than analytical approach, limiting theoretical integration across digital marketplaces, value chains, and entrepreneurship. Second, there is a scarcity of region-specific empirical research examining the combined effects of digital technologies on income generation, value chain transformation, and entrepreneurial development. Third, limited attention has been given to the intersection between digital platforms and value-added agricultural enterprises within South Africa.

## **2.5 Conclusion of the Literature Review**

The literature demonstrates that digital marketplaces and e-commerce platforms significantly enhance agricultural market access, strengthen value chain efficiency, and promote rural entrepreneurship. These technologies improve price transparency, facilitate financial inclusion, and enable smallholder farmers to participate more effectively in competitive markets. However, the adoption of digital agriculture remains uneven due to persistent infrastructural, institutional, and socio-economic constraints. A critical synthesis of the reviewed studies reveals that, although global and regional research highlights the transformative potential of digital technologies, limited empirical work has explored their integrated impact within specific rural contexts. In Limpopo Province, scholarly attention remains particularly scarce regarding the influence of digital platforms on income generation, value chain participation, and entrepreneurial development. By incorporating localized evidence, including the study by Ngwepe and Motsepe (2026), this research addresses a significant gap in the literature. Accordingly, this study contributes to the advancement of knowledge by providing a context-specific analysis of how digital marketplaces and e-commerce platforms are reshaping rural agricultural economies. It offers theoretical, empirical, and policy-relevant insights into the role of digital technologies in fostering inclusive agricultural development and sustainable rural transformation.

## **2.7 Theoretical Framework**

This study draws on two complementary theoretical perspectives to analyse the role of digital marketplaces in rural agricultural systems: Agricultural Value Chain Theory and Digital Entrepreneurship Theory. Agricultural Value Chain Theory provides a framework for understanding how agricultural products move from producers to consumers through interconnected economic activities. Value chains consist of activities that create value at different stages of production, processing, distribution, and marketing (Birner et al., 2021; Baumüller et al., 2023). Although originally developed in industrial contexts, the framework has been widely applied in agricultural development research to analyse how

market linkages affect farmer incomes, coordination, and efficiency (Zhao et al., 2019; Rose et al., 2021). Recent studies highlight the role of digital transformation in reshaping value chains. Digital technologies improve information flows, reduce transaction costs, and strengthen coordination among actors, allowing smallholder farmers to engage more effectively with markets (Gumbi et al., 2023; Morepje et al., 2024). Digital marketplaces act as intermediating infrastructures that facilitate new forms of economic interaction between farmers and buyers, promoting inclusion and enhancing transparency (Fabregas et al., 2022; World Bank, 2025b). Digital Entrepreneurship Theory provides additional insights into how digital platforms influence rural economic activity. Digital entrepreneurship refers to entrepreneurial activities that rely on digital technologies to create, deliver, or capture economic value (Rose & Chilvers, 2018; Gwelo, 2025). Digital tools reduce barriers to entry for rural entrepreneurs by enabling access to broader markets and scalable business models (Manzoor et al., 2025). In agricultural contexts, digital entrepreneurship empowers farmers to evolve from solely being producers into entrepreneur actors who actively influence the marketing, distribution, and positioning of their products. Rather than depending exclusively on intermediaries such as wholesalers or retailers, farmers can leverage digital tools to engage in higher value-adding segments of the supply chain. Platforms enable branding, customer engagement, and e-commerce participation, which strengthen income diversification and entrepreneurial resilience (Chandra & Collis, 2021; Duguma & Bai, 2025; Ngwepe & Motsepe, 2026).

By integrating Agricultural Value Chain Theory and Digital Entrepreneurship Theory, this study provides a comprehensive framework for analysing how digital marketplaces influence income generation and entrepreneurial development among rural farmers (World Bank, 2021; AU, 2024).

### 3. Methodology

This study adopts a qualitative systematic literature review to examine the role of digital marketplaces and e-commerce platforms in rural agricultural systems. Systematic reviews enable researchers to identify, evaluate, and synthesise existing knowledge in a transparent and structured manner (Klerk et al., 2019; Snyder, 2019;).

#### 3.1 Data Sources and Search Strategy

Relevant literature was identified through major academic databases which include Scopus, Web of Science, Google Scholar, and ScienceDirect. Reports from international organisations such as the FAO, World Bank, and AU were also included due to their relevance to digital agriculture and rural development (FAO, 2022; AU, 2024; World Bank, 2025a). The search used combinations of keywords such as digital agriculture, e-commerce in agriculture, digital marketplaces for farmers, digital platforms, rural agricultural entrepreneurship, digital value chains and smallholder farmers and.

Only publications produced between 2020 and 2026 were included to ensure that the study reflects recent developments in digital agriculture (Manzoor et al., 2025; Nxumalo & Chauke, 2025).

#### 3.2 Inclusion Criteria

Studies were included if they:

- ✧ Were published between 2020 and 2026,

- ❖ Focused on digital agriculture, agricultural e-commerce, or digital marketplaces,
- ❖ Examined impacts on farmers, agricultural value chains, or rural entrepreneurship,
- ❖ Were published in peer-reviewed journals or credible institutional reports,
- ❖ Were available in English (World Bank, 2025a; OECD, 2022)

### 3.3 Exclusion Criteria

Studies were excluded if they:

- ❖ Were published before 2020 unless considered foundational,
- ❖ Focused solely on agricultural production technologies without market implications,
- ❖ Were non-academic opinion pieces or unpublished manuscripts,
- ❖ Lacked clear methodological transparency (Shepherd et al., 2020; Rose et al., 2021)

### 3.4 Literature Selection and Evaluation

The initial database search produced approximately 98 articles. After screening titles and abstracts, 55 studies remained. Full-text review resulted in a final sample of 33 publications meeting inclusion criteria. Each article was evaluated for methodological quality, relevance to digital marketplaces, and empirical contribution to understanding rural agricultural systems (Schroeder et al., 2021; Fabregas et al., 2022). Data from the selected studies were coded and analysed using thematic analysis to identify recurring patterns related to income generation, value chain transformation, and agricultural entrepreneurship (Morepje et al., 2024; Gwelo, 2025). Because this study relies exclusively on publicly available secondary data, it does not involve human participants, confidential information, or primary data collection; therefore, ethical clearance was not required (United Nations General Assembly [UNGA], 2025).

## 4 Results

### 4.1 Digital Marketplaces and Income Generation among Rural Farmers

Recent studies show that involvement in digital marketplaces enhances income opportunities for rural farmers by broadening market access and increasing price transparency. Smallholder farmers often rely on informal marketing channels where intermediaries enjoy the benefit of determining prices and controlling distribution networks. Digital platforms reduce this dependency by enabling direct interaction between farmers and buyers, allowing farmers to obtain more competitive prices and stable demand (FAO, 2022; World Bank, 2025b). Studies examining digital agricultural platforms indicate that farmers benefit from improved and smooth of flow information. Digital marketplaces provide real-time data on market prices, demand trends, and logistics options (Aker & Fafchamps, 2015; Baumüller et al., 2023). Farmers who have access to price information can negotiate more effectively and decide when and where to sell their produce (World Bank, 2021). Research focusing on African smallholder farmers shows that digital marketplaces increase farmers' bargaining power within agricultural markets. Farmers using digital platforms experience higher average selling prices compared to those relying on traditional local markets due to simultaneous access to multiple buyers (Fabregas et al., 2022; Gumbi et al., 2023). In contexts such as Limpopo Province, farmers face limited market infrastructure and high transportation costs in pursuit to formal markets.

Digital platforms help overcome these barriers through online product listings and digital logistics networks that coordinate deliveries (Baumüller et al., 2023; Morepje et al., 2024). Digital payment

systems are critical for income generation. Mobile payment technologies allow farmers to receive secure payments, reducing risks associated with cash transactions and strengthening financial inclusion (World Bank, 2021; FAO, 2022). These findings indicate that digital marketplaces influence rural agricultural income through several mechanisms: improved price transparency, expanded market reach, reduced transaction costs, and greater financial inclusion. The extent of these benefits depends on farmers’ access to digital infrastructure and skills (Manzoor et al., 2025; Nxumalo & Chauke, 2025). The mechanisms through which digital marketplaces enhance rural farmers’ incomes can be illustrated by examining specific benefits that these platforms provide. Table 2 summarises key income effects, highlighting how access to real-time information, direct buyer connections, expanded market reach, digital payments, and reduced transaction costs contribute to improved financial outcomes for smallholder producers. Each mechanism reflects evidence from contemporary studies that demonstrate the practical impact of digital tools on agricultural livelihoods.

**Table 2. Key Income Effects of Digital Marketplaces for Rural Farmers**

Mechanism	Description
Price transparency	Access to real-time market prices and demand data
Reduced intermediaries	Direct connections increase profit margins
Market expansion	Reach urban consumers and institutional buyers
Digital payments	Secure transactions and financial inclusion
Reduced transaction costs	Lower search and negotiation costs

*Source: Aker & Fafchamps (2015); World Bank (2021); Fabregas et al. (2022); FAO (2022); Baumüller et al. (2023).*

These mechanisms collectively demonstrate that digital marketplaces do more than simply provide an additional sales channel; they reshape the financial landscape for rural farmers by enabling greater autonomy, informed decision-making, and participation in higher-value markets. Nevertheless, the degree to which these benefits are realised is strongly influenced by farmers’ digital literacy skills and access to reliable digital infrastructure and connectivity (Manzoor et al., 2025; Nxumalo & Chauke, 2025). Consequently, policy interventions that improve rural broadband, provide digital skills training, and support integration into digital ecosystems are critical to ensuring that smallholder farmers can fully leverage these platforms. When effectively implemented, these measures can transform market participation into sustained income growth, strengthen rural economies, and promote equitable development within agricultural communities.

#### 4.2 E-Commerce Platforms and Agricultural Value Chain Transformation

E-commerce platforms contribute to structural changes within agricultural value chains. Traditional chains involve multiple intermediaries who control prices and limit farmers’ access to the ultimate consumers. Digital technologies reduce these inefficiencies by facilitating direct communication and coordination between actors (Birner et al., 2021; Rose et al., 2021). Digital platforms enable more transparent relationships among producers, retailers, and consumers. They provide digital communication channels and product tracking systems, enhancing trust and market efficiency (Zhao et al., 2019; Krone et al., 2023;). Traceability systems are another key feature of digital value chains. E-commerce platforms allow agricultural products to be tracked from farm to market through digital data systems, supporting food safety monitoring and quality assurance (Schroeder et al., 2021; FAO, 2022).

Improved logistics coordination also emerges as a significant transformation. Digital platforms integrate transportation services that connect farmers with delivery providers, reducing supply chain delays and potential post-harvest losses (World Bank, 2021; Duguma & Bai, 2025). Additionally, e-commerce supports cooperative marketing structures. Farmers can form digital groups to collectively advertise products and negotiate with buyers, strengthening bargaining power and supply consistency (Baumüller et al., 2023; Morepje et al., 2024). Digital platforms not only facilitate individual market access but also enable collective action among farmers. By forming digital groups, producers can coordinate product listings, negotiate with buyers, and ensure more consistent supply, thereby enhancing both their market influence and operational efficiency. Table 3 summarises the keyways in which digital technologies transform agricultural value chains, highlighting the contributions of digital tools across coordination, traceability, logistics, consumer engagement, and cooperative marketing.

**Table 3. Digital Transformation within Agricultural Value Chains**

Value Chain Function	Digital Platform Contribution
Market coordination	Direct communication between producers and buyers
Product traceability	Digital tracking of agricultural products
Logistics integration	Coordination of transport and delivery services
Consumer engagement	Direct interaction between farmers and customers
Cooperative marketing	Collective digital marketing by farmer groups

*Source: World Bank (2021); Fabregas et al. (2022); FAO (2022); Baumüller et al. (2023); Krone et al. (2023).*

These functions collectively illustrate how digital platforms restructure traditional agricultural value chains, reducing inefficiencies, improving transparency, and fostering stronger market relationships. By integrating communication, traceability, logistics, and collaborative marketing, farmers are better positioned to compete in higher-value markets, respond effectively to consumer demand, and strengthen their resilience against market fluctuations. Ultimately, digital transformation in value chains represents a strategic avenue for increasing productivity, enhancing income stability, and empowering rural communities to participate more fully in modern agricultural economies.

#### 4.3 Digital Platforms and the Emergence of Rural Agricultural Entrepreneurship

Digital marketplaces foster rural entrepreneurship by allowing farmers to develop independent marketing strategies and diversify business activities. Farmers can sell fresh produce directly to consumers, develop branded products, or participate in niche markets (Agarwal et al., 2022; Gwelo, 2025). Value addition activities such as processing and packaging agricultural products increase product value and enable farmers to capture higher profits (FAO, 2022; Morepje et al., 2024; Ngwepe & Motsepe, 2026). Digital marketing capabilities, including images, product descriptions, and customer feedback systems, support brand development and customer loyalty (Rose & Chilvers, 2018; Fabregas et al., 2022). Barriers remain, including limited internet connectivity and low digital literacy in rural areas. Effective participation in digital agricultural markets requires more than technology; it also depends on training, institutional support, and access to relevant tools that empower farmers to develop entrepreneurial skills (FAO, 2022; Nxumalo & Chauke, 2025). Table 4 highlights the key drivers of digital agricultural entrepreneurship and the associated outcomes for rural farmers.

**Table 4. Drivers of Digital Agricultural Entrepreneurship**

Driver	Entrepreneurial Outcome
Digital marketing tools	Brand development and customer engagement
Online marketplaces	Direct-to-consumer agricultural sales
Value addition	Processing and packaging of agricultural products
Digital payments	Improved financial management and transactions
Farmer networks	Cooperative entrepreneurship models

*Source: World Bank (2021); Agarwal et al. (2022); Fabregas et al. (2022); FAO (2022); Krone et al. (2023); Ngwepe & Motsepe, 2026*

These drivers collectively demonstrate that digital marketplaces are not merely channels for selling produce but platforms for fostering innovation, value creation, and entrepreneurial agency among rural farmers. By leveraging digital tools, engaging in cooperative networks, and participating in value-added activities, farmers can diversify income streams, strengthen market presence, and build resilience against economic and environmental uncertainties. Ultimately, the integration of technology, knowledge, and institutional support underscores the transformative potential of digital agriculture to empower smallholders and drive sustainable rural development.

## 5. Discussion

The results demonstrate that digital marketplaces and e-commerce platforms play an increasingly important role in transforming rural agricultural economies. Evidence indicates that digital technologies enhance income opportunities, strengthen agricultural value chains, and promote entrepreneurial activity among rural farmers (World Bank, 2021; FAO, 2022; Baumüller et al., 2023). The first major finding relates to income generation. Digital marketplaces provide farmers with improved price transparency, broader market access, and secure digital payment systems. These outcomes reduce information asymmetries and enhance bargaining power, consistent with findings by Fabregas et al. (2022) and World Bank (2025d). By enabling farmers to access real-time market data and multiple buyers, digital platforms reduce dependence on intermediaries and support financial inclusion (Aker & Fafchamps, 2015; FAO, 2022; Morepje et al., 2024).

The second finding concerns the transformation of agricultural value chains. Digital platforms facilitate stronger coordination among producers, buyers, and logistics providers. Traceability systems, logistics integration, and direct communication channels improve efficiency, transparency, and trust within supply chains (Zhao et al., 2019; World Bank, 2021; Krone et al., 2023). These findings align with prior analyses emphasizing that digital infrastructures restructure traditional value chain relationships and enhance overall market functionality (Birner et al., 2021; Rose et al., 2021).

The third finding relates to rural agricultural entrepreneurship. Digital platforms enable farmers to adopt entrepreneurial practices, including branding, product differentiation, and direct-to-consumer marketing (Agarwal et al., 2022; Gwelo, 2025). These developments illustrate the potential of digital technologies to lower barriers to entry and create new economic opportunities for smallholder farmers, reinforcing the theoretical perspective of digital entrepreneurship (Yuan & Sun, 2024; Manzoor et al., 2025). Despite these benefits, structural challenges persist. Limited digital infrastructure, poor internet connectivity, and insufficient digital skills continue to restrict the adoption of digital agriculture,

particularly in rural areas such as Limpopo Province (Bontsa et al., 2023; Nxumalo & Chauke, 2025). These constraints highlight the ongoing digital divide and underscore the need for equitable access to technology and training (Rotz et al., 2019; Mehrabi et al., 2021). The discussion therefore emphasizes the importance of policy interventions to address these constraints. Investment in rural broadband infrastructure, digital literacy programs, and supportive regulatory frameworks are essential for ensuring that digital agriculture benefits are distributed equitably among smallholder farmers (AU, 2024; UNGA, 2025; WFO, 2025; OECD, 2025). Such measures can enhance income generation, value chain efficiency, and entrepreneurship while mitigating the risks of exclusion in the digital transition of agriculture (Shepherd et al., 2020; Schroeder et al., 2021).

This study makes a distinctive contribution to the literature on digital agriculture by providing a context-specific analysis of how digital marketplaces and e-commerce platforms are transforming rural agricultural economies in Limpopo Province, South Africa. While existing research broadly examines the role of digital technologies in agricultural development, limited scholarly attention has been devoted to their integrated impact on income generation, value chain transformation, and rural entrepreneurship within the South African context. This research addresses that gap by offering a holistic and regionally grounded perspective. The study advances theoretical understanding by synthesising Agricultural Value Chain Theory and Digital Entrepreneurship Theory to explain how digital platforms reshape market structures and empower smallholder farmers as entrepreneurial actors. Empirically, it contributes localized insights that bridge global digital agriculture debates with the realities of rural communities in Limpopo. Methodologically, the inclusion of synthesis tables and critical analysis enhances the analytical rigor of the literature. Practically, the findings provide policy-relevant recommendations for promoting inclusive digital transformation, strengthening food security, and fostering sustainable rural development. Collectively, the study offers valuable academic, policy, and developmental insights into the evolving digitalisation of agriculture.

## **6. Conclusion**

Digital marketplaces and e-commerce platforms are transforming agricultural marketing systems by enabling rural farmers to access wider markets, improve price transparency, and participate more actively in agricultural value chains. These platforms allow farmers to interact directly with buyers, negotiate prices, and manage logistics efficiently, reducing dependence on intermediaries and fostering fairer transactions. The findings demonstrate that digital platforms support income generation, strengthen supply chain coordination, and encourage entrepreneurial activity among smallholder farmers. Beyond immediate financial benefits, these technologies contribute to building resilience, enhancing operational efficiency, and supporting sustainable agricultural practices. Digital platforms, therefore, represent an important mechanism for promoting rural economic development and long-term agricultural sustainability.

## **Practical Implications**

For these benefits to be fully realised, governments and agricultural development agencies should prioritise investments in rural digital infrastructure to expand internet connectivity and improve access to digital tools within farming communities. Training programmes focused on digital literacy, e-commerce skills, and online marketing are essential to ensure that farmers can effectively utilise digital

platforms. Policymakers should also facilitate partnerships between agricultural cooperatives, technology providers, and financial institutions to design inclusive and accessible marketplaces. Such collaborative approaches can provide technical support, affordable access to digital resources, and financial solutions that empower smallholder farmers. Encouraging cooperative networks and collective marketing strategies further strengthens farmers' bargaining power, increases supply consistency, and enhances participation in value chains. These practical steps are crucial for maximising the transformative potential of digital agriculture.

### Theoretical Implications and Further Research

From a theoretical perspective, this study contributes to the understanding of how digital technologies intersect with agricultural value chains and entrepreneurship. By integrating insights from value chain coordination and digital entrepreneurship, the study demonstrates how digital platforms are important in reshaping traditional agricultural systems while creating new economic opportunities. Future research should focus on empirical investigations within specific rural communities to assess adoption patterns, barriers to engagement, and the long-term effects of digital marketplaces. Longitudinal studies would be particularly valuable in understanding how sustained digital engagement influences rural economic resilience, income diversification, and local development trajectories. Examining the socio-economic and behavioural factors that support or inhibit digital adoption can also inform policies and interventions aimed at inclusive agricultural development. In conclusion, digital marketplaces and e-commerce platforms are more than technological innovations; they are transformative tools that empower rural farmers, enhance market efficiency, and foster entrepreneurial growth. By improving access to information, strengthening value chain integration, and enabling income diversification, these platforms hold the potential to drive sustainable rural development and advance agricultural productivity. Realising this potential, however, requires coordinated investments in infrastructure, education, and supportive institutional frameworks to ensure that the benefits of digital agriculture are equitable, inclusive, and enduring.

### Acknowledgements

Authors extend sincere appreciation to the Limpopo Department of Agriculture and Rural Development for providing an enabling environment that made it possible for us to undertake this work. Their support and commitment are gratefully acknowledged.

### References

- African Union. (2024). African Union Digital Agriculture Strategy (DAS) and implementation plan, 2024–2030 (Continental digital agriculture policy framework). African Union Commission. [https://au.int/sites/default/files/documents/43481-doc-DAS\\_EN.pdf](https://au.int/sites/default/files/documents/43481-doc-DAS_EN.pdf)
- Aker, J. C., & Fafchamps, M. (2015). Mobile phone coverage and producer markets: Evidence from West Africa. *The World Bank Economic Review*, 29(2), 262–292. <https://doi.org/10.1093/wber/lhu006>
- Baumüller, H., Ikpi, U., Jumpah, E. T., Kamau, G., Kergna, A. O., Mose, L. O., Nientao, A., Omari, R., Phillip, D., & Salasya, B. D. (2023). Building digital bridges in African value chains: Exploring linkages between ICT use and social capital in agricultural marketing. *Journal of Rural Studies*, 100, 103002. <https://doi.org/10.1016/j.jrurstud.2023.03.010>

- Birner, R., Daum, T., & Pray, C. (2021). Who drives the digital revolution in agriculture? A review of supply side trends, players and challenges. *Applied Economic Perspectives and Policy*, 43(4), 1260–1285. <https://doi.org/10.1002/aepp.13145>
- Bontsa, N. V., Mushunje, A., & Ngarava, S. (2023). Factors influencing the perceptions of smallholder farmers towards adoption of digital technologies in Eastern Cape Province, South Africa. *Agriculture*, 13(8), 1471. <https://doi.org/10.3390/agriculture13081471>
- Chandra, R., & Collis, S. (2021). Digital agriculture for small-scale producers: Challenges and opportunities. *Communications of the ACM*, 64(12), 75–84. <https://doi.org/10.1145/3454008>
- Duguma, A. L., & Bai, X. (2025). How the Internet of Things technology improves agricultural efficiency. *Artificial Intelligence Review*, 58, 63. <https://doi.org/10.1007/s10462-024-11046-0>
- Fabregas, R., Kremer, M., & Schilbach, F. (2022). Realizing the potential of digital development: The case of agricultural advice. *Science*, 366(6471). <https://doi.org/10.1126/science.aay3038>
- Food and Agriculture Organization. (2022). The state of food and agriculture 2022: Leveraging automation in agriculture for transforming agrifood systems. FAO. <https://doi.org/10.4060/cb9479en>
- Gumbi, N., Gumbi, L., & Twinomurinzi, H. (2023). Towards sustainable digital agriculture for smallholder farmers: A systematic literature review. *Sustainability*, 15(16), 12530. <https://doi.org/10.3390/su151612530>
- Gwelo, F. A. (2025). Social media apps and the democratisation of agricultural knowledge. *Journal of the Knowledge Economy*. <https://doi.org/10.1007/s13132-025-02837-z>
- Klerkx, L., Jakku, E., & Labarthe, P. (2019). A review of social science on digital agriculture and smart farming. *NJAS: Wageningen Journal of Life Sciences*, 90–91, 100315. <https://doi.org/10.1016/j.njas.2019.100315>
- Manzoor, F., Wei, L., Siraj, M., Lu, X., & Guo, Q. (2025). Digital agriculture technology adoption in low- and middle-income countries: A review of contemporary literature. *Frontiers in Sustainable Food Systems*, 9, Article 1621851. <https://doi.org/10.3389/fsufs.2025.1621851>
- Mehrabi, Z., McDowell, M. J., Ricciardi, V., Levers, C., Martinez, J. D., Mehrabi, N., Wittman, H., Ramankutty, N., & Jarvis, A. (2021). The global divide in data-driven farming. *Nature Sustainability*, 4(2), 154–160. <https://doi.org/10.1038/s41893-020-00631-0>
- Morepje, M. T., Sithole, M. Z., Msweli, N. S., & Agholor, A. I. (2024). The influence of e-commerce platforms on sustainable agriculture practices among smallholder farmers in Sub-Saharan Africa. *Sustainability*, 16(15), 6496. <https://doi.org/10.3390/su16156496>
- Ngwepe, M. R., & Motsepe, H. L. (2026). Assessing the Potential Economic Viability of Mango Value Addition in the Waterberg District, Limpopo Province. *Journal of Agriculture and Rural Development Studies*. <https://doi.org/10.35219/jards.2026.1.15>
- Nxumalo, G. N., & Chauke, H. (2025). Challenges and opportunities in smallholder agriculture digitization in South Africa. *Frontiers in Sustainable Food Systems*, 7, 1583224. <https://doi.org/10.3389/fsufs.2025.1583224>
- Organisation for Economic Co operation and Development. (2022). The digitalisation of agriculture (OECD Food, Agriculture and Fisheries Papers No. 176). OECD Publishing. [https://www.oecd.org/en/publications/the-digitalisation-of-agriculture\\_285cc27d-en.html](https://www.oecd.org/en/publications/the-digitalisation-of-agriculture_285cc27d-en.html)
- Organisation for Economic Co operation and Development. (2025). Agricultural policy monitoring and evaluation 2025: Developments in agricultural policies and support by country (OECD Publishing).

[https://www.oecd.org/en/publications/2025/10/agricultural-policy-monitoring-and-evaluation-2025\\_354e7040.html](https://www.oecd.org/en/publications/2025/10/agricultural-policy-monitoring-and-evaluation-2025_354e7040.html)

- Rose, D. C., & Chilvers, J. (2018). Agriculture 4.0: Broadening responsible innovation in an era of smart farming. *Frontiers in Sustainable Food Systems*, 2, Article 87. <https://doi.org/10.3389/fsufs.2018.00087>
- Rose, D. C., Wheeler, R., Winter, M., Lobley, M., & Chivers, C. A. (2021). Agriculture 4.0: Making it work for people, production, and the planet. *Land Use Policy*, 100, 104933. <https://doi.org/10.1016/j.landusepol.2020.104933>
- Rotz, S., Gravelly, E., Mosby, I., Duncan, E., Finnis, E., Horgan, M., LeBlanc, J., Martin, R., Neufeld, H. T., Nixon, A., & Pant, L. (2019). Automated pastures and the digital divide: How agricultural technologies shape labour and rural communities. *Journal of Rural Studies*, 68, 112–122. <https://doi.org/10.1016/j.jrurstud.2019.01.023>
- Schroeder, K., Lampiotti, J., & Elabed, G. (2021). What’s cooking: Digital transformation of the agrifood system (Agriculture and Food Series). World Bank. <https://doi.org/10.1596/978-1-4648-1657-4>
- Shepherd, M., Turner, J. A., Small, B., & Wheeler, D. (2020). Priorities for science to overcome hurdles thwarting the full promise of the ‘digital agriculture’ revolution. *Journal of the Science of Food and Agriculture*, 100(14), 5083–5092. <https://doi.org/10.1002/jsfa.9346>
- Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333–339. <https://doi.org/10.1016/j.jbusres.2019.07.039>
- United Nations General Assembly. (2025). Digital technologies and sustainable agrifood systems (A/80/377). United Nations. <https://docs.un.org/en/A/80/377>
- World Bank. (2021). Digital agriculture: Opportunities and policy directions. World Bank. <https://doi.org/10.1596/978-1-4648-1657-4>
- World Bank. (2025a). Digital Progress and Trends Report 2025. World Bank. <https://documents1.worldbank.org/curated/en/099112525160593874/pdf/P505350-d12bf50c-2e65-4863-822b-8fb9e69bda4b.pdf>
- World Bank. (2025b). Digital Agriculture Roadmap (DAR) Playbook (with insights for policy makers and governments on strategy and implementation). World Bank. <https://documents1.worldbank.org/curated/en/099053025063021993/pdf/P508004-f943a09b-c45f-4c93-b554-9dd1decd1e7c.pdf>
- World Bank. (2025c). From fields to markets: Digital platforms in West Africa’s agricultural success. World Bank. <https://www.worldbank.org/en/results/2025/03/04/afw-from-fields-to-markets-the-role-of-digital-platforms-in-west-africa-agricultural-success>
- World Farmers’ Organisation. (2025). Policy on digitalisation and artificial intelligence in agriculture (Policy document outlining farmer centric digital and AI governance principles). <https://www.wfo-oma.org/policy-development/policy-documents>
- Yuan, Y., & Sun, Y. (2024). Practices, challenges, and future of digital transformation in smallholder agriculture: Insights from a literature review. *Agriculture*, 14(12), 2193. <https://doi.org/10.3390/agriculture14122193>
- Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., & Boshkoska, B. M. (2019). Blockchain technology in agri food value chain management: A synthesis of applications, challenges, and future research directions. *Computers in Industry*, 109, 83–99. <https://doi.org/10.1016/j.compind.2019.04.002>