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Digital transformation in South Africa's agri-business sector: Opportunities and challenges

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ABSTRACT

Digital transformation is significantly reshaping the global agribusiness sector, with South Africa actively participating in this technological shift. This paper investigates the influence of digital technologies on enhancing productivity, sustainability, and competitiveness within South African agriculture. The adoption of innovations such as precision agriculture, artificial intelligence (AI), Internet of Things (IoT), and blockchain is increasingly viewed as essential for addressing challenges related to climate change, food insecurity, and economic instability. The study highlights the potential of digital transformation to improve supply chain transparency, expand market access, and strengthen risk management. However, it also acknowledges persistent obstacles to adoption. These include poor digital infrastructure in rural regions, high technology implementation costs, limited technical skills, and gaps in digital literacy, particularly among smallholder farmers. By drawing on literature reviews, policy analysis, and empirical case studies, the paper provides a balanced assessment of both opportunities and limitations associated with digital agriculture in the South African context. Findings reveal that while large commercial farms are increasingly utilizing digital tools, small-scale farmers face systemic barriers that limit their participation in the digital economy. As a result, the paper advocates for inclusive digital strategies and capacity-building programs aimed at closing the digital divide. It emphasizes that the success of digital transformation in South African agri-business depends heavily on coordinated efforts among government, industry players, and local farming communities to ensure broad-based access and equitable outcomes.

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Introduction

Agriculture remains a cornerstone of the South African economy and makes an important contribution to employment, food security and rural development (Venter, 2018). However, the sector faces numerous challenges, including land degradation, climate variability, water scarcity and limited market access for smallholder farmers (Phetla, 2017; De Satgé et al., 2020; Pengelly et al., 2021). In response to these pressures, digital transformation has emerged as a critical mechanism to modernize the agricultural sector and improve its resilience, efficiency and sustainability.

Digital transformation in agribusiness refers to the integration of digital technologies into agricultural operations, processes and value chains. It encompasses a wide range of innovations such as artificial intelligence (AI), Internet of Things (IoT), blockchain, satellite imagery, mobile platforms and big data analytics (Liu et al., 2023). These technologies enable farmers and agribusinesses to optimize planting decisions, monitor soil and plant health in real time, streamline supply chains and improve product traceability. In developed countries, such innovations have already revolutionized agricultural practices, leading to higher productivity and sustainability. South Africa, with its diverse agricultural areas and strong technological infrastructure in urban areas, is in a unique position to benefit from digital agriculture (Kosior, 2018; Ndekwa et al.,2023).

Despite the potential, the level of adoption of digital technologies in the South African agricultural economy remains uneven. Large commercial farms that have access to capital and skilled labour are more likely to integrate advanced technologies. Conversely,

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smallholder and emerging farmers often lack the infrastructure, financial resources and digital skills to do the same (Mhlanga, 2024; Bello,2024). The digital divide is exacerbated by poor internet connectivity in rural areas, high data costs and limited institutional support (Smidt et al., 2022).

The South African government has recognized the importance of digital transformation and has included digital agriculture in its strategic frameworks. For example, the Master Plan for Agriculture and Agribusiness (2022) emphasizes the role of technology in promoting inclusive growth, job creation and food security. The National Development Plan 2030 also envisages a competitive and inclusive agricultural sector supported by innovation and knowledge transfer (NPC, 2012). However, implementation is slow and collaboration between the public and private sectors is essential to accelerate progress.

In addition, the COVID-19 pandemic has further highlighted vulnerabilities in agricultural supply chains and increased the need for robust digital systems to facilitate remote communication, online marketing and real-time data sharing (OECD, 2020). Digital tools have enabled some farmers to reach consumers directly during the lockdown, highlighting their role in improving market access and resilience.

The global shift towards digital agriculture has been extensively studied in recent years. According to Ozdogan, et al. (2017), digital agriculture uses technologies such as AI, IoT and mobile applications to improve decision-making, efficiency and profitability in agriculture. The integration of these technologies has achieved remarkable results in high-income countries where infrastructure and digital skills are more readily available.

In the South African context, several researchers have highlighted the growing role of digital innovation in agriculture. Smidt and Jokonya (2022) pointed out that technologies such as precision agriculture and mobile-based extension systems are gradually gaining traction, especially among large commercial farms. However, they also noted significant barriers, including cost, connectivity and training.

Gumbi, Gumbi and Twinomurinzi (2023) examined the digital divide in rural South Africa and found that digital illiteracy, poor infrastructure and socio-economic exclusion are the main barriers to the widespread adoption of digital tools in agriculture. Mhlanga and Ndhlovu (2023) also emphasized the potential of digital agriculture to transform food systems in developing countries, if inclusion and infrastructure are prioritized.

In addition, studies by the OECD (2020) and Sridhar et al. (2023) during the COVID-19 pandemic illustrated the importance of digital tools in sustaining farms and maintaining food supply chains during lockdown. These findings support the argument that digital transformation is not only a tool for growth, but also a critical component of agricultural resilience.

This paper aims to explore the dual nature of digital transformation in South African agribusiness: its opportunities and its challenges. By examining the policy framework, current practices and barriers to adoption, the study seeks to identify pathways for inclusive and sustainable digital agriculture. Particular attention is paid to the differences between commercial and smallholder farms, with a focus on how digital inclusion can be promoted across all segments of the sector.

Research and Methodology

This study uses a qualitative research design that employs a combination of literature review, policy analysis and empirical case studies to assess the impact and challenges of digital transformation in the South African agricultural sector. Data is drawn from academic journals, government reports, non-governmental organization (NGO) publications and case studies of local agribusinesses.

The literature review focused on identifying key trends and technologies in digital agriculture at global and local levels. The policy analysis examined South Africa's national frameworks such as the Agriculture and Agro-Processing Master Plan (2022) and the National Development Plan 2030. Case studies were conducted using documented examples of digital technology adoption by both commercial and smallholder farmers and offered practical insights into adoption patterns and barriers.

A thematic analysis approach was used to interpret the findings from the literature and case studies. This involved coding the qualitative data into themes such as "benefits of digital agriculture'," "barriers to adoption'," "policy support" and "digital inclusion". These themes form the basis of the 'Discussion' section.

Findings and Discussions

Discussions

The integration of digital technologies into the South African agricultural sector is in line with international findings on the impact of digital transformation on agriculture (World Bank, 2019; Ranganai et al., 2022). In this study, large commercial farms showed improved productivity, better risk management and better access to markets through the adoption of AI and IoT-based systems, which is consistent with the findings of Spielman (2021) and Gamede (2022).

In contrast, smallholder farmers continue to face significant barriers. These include limited access to reliable internet, financial constraints and inadequate training — barriers reflected in the work of Phiri et al. (2019). These constraints have led to an uneven

digital transformation, with digital tools primarily benefiting better-equipped commercial operations. These finding echoes similar global concerns about digital inequality in agriculture (Makhura, 2021).

The policy analysis found that while national strategies recognize the need for technological integration, implementation is inconsistent. This is in line with the recommendations of the OECD (2020), which calls for a coordinated approach by all stakeholders to improve digital infrastructure and access. The pandemic has underlined the potential of digital solutions for supply chain continuity and confirmed the OECD's assertion that digital readiness is critical in times of crisis.

Recommendations derived from this study include the development of rural connectivity programs, financial support mechanisms for technology adoption by smallholder farmers and targeted training initiatives. Below is a visual summary of these challenges and proposed solutions.

Challenges and proposed solutions in agri-business



Figure 1: Challenges and Proposed Solutions

This visual graphic (Figure 1) illustrates the impact of the challenges of digital transformation on commercial and smallholder farms. As you can see, smallholder farmers are significantly more affected by infrastructure gaps, technology costs and digital literacy issues, which supports the findings of the study.

Addressing key challenges in digital agriculture: A contextual overview

The integration of digital technologies into agriculture, particularly in semi-arid and rural areas such as Ladismith in the Karoo, promises to revolutionise farming practises, productivity and sustainability. However, the adoption of these innovations is often hindered by several structural and socio-technical barriers. The figure above succinctly outlines four critical challenges — infrastructure gaps, technology costs, skills gaps and digital literacy— - and actionable solutions that can be pursued to promote inclusive digital transformation in agriculture.

i. Gaps in the infrastructure:

Rural areas often suffer from limited access to stable electricity, internet connections and mobile phone networks. These infrastructural deficits hinder the operation of smart devices, remote sensing tools and cloud-based platforms that underpin precision agriculture. The proposed solution — investing in rural digital infrastructure— - requires a concerted effort by governments, private sector actors and development agencies to build reliable ICT systems to lay the foundation for digital agriculture.

ii. Technology costs:

The financial burden associated with the acquisition of digital tools such as drones, sensors, software and maintenance services remains a major hurdle for smallholder and emerging farmers. To solve this problem, it is important to provide affordable access to digital tools through subsidised programmes, public-private partnerships and scalable leasing models. This would lower the barrier to entry for many farmers and improve the acceptance of the technology.

iii. Skills shortages:

Even when technologies are available, many farming communities lack the human capital necessary to operate and manage them effectively. This includes technical know-how, the ability to analyse data and the ability to make strategic decisions. To address this gap, a concerted effort must be made to provide training and education programmes, including extension services, digital literacy workshops and agricultural innovation centres specifically tailored to local needs.

iv. Digital Literacy:

Closely related to skills development is the broader issue of digital literacy. Many rural farmers may not be familiar with basic digital interfaces, mobile applications or data dashboards. The solution lies in improving farmers' digital skills through targeted interventions that build confidence and competence in using digital tools, thus promoting long-term technological integration.

To summarise, while the figure provides a clear and visual summary of the main barriers and solutions in digital agriculture, in a broader sense a systemic approach involving multiple stakeholders is required. Overcoming these challenges not only facilitates the use of technology, but also enables farmers to make informed decisions, improve their yields, adapt to climate variability and participate meaningfully in the digital economy.

Conclusion

Digital transformation presents both significant opportunities and ongoing challenges for the South African agricultural industry. While digital tools have the potential to improve productivity, sustainability and market resilience, the sector continues to face a pronounced digital divide — characterised by gaps in infrastructure, affordability constraints and limited digital skills among smallholder farmers. To fully realise the transformative power of digital agriculture, inclusive and context-specific strategies need to be implemented. These should focus on expanding rural connectivity, subsidising technology costs and promoting digital literacy through targeted education and training initiatives.

A multi-stakeholder model is crucial. Collaboration between national and provincial governments, Agri-tech companies, research organisations and farmer cooperatives are key to developing scalable and locally relevant solutions. Policy makers must also ensure that digital transformation efforts are aligned with overall development goals, such as reducing rural poverty, improving food security and strengthening climate resilience.

Long-term success will depend not only on the use of technology, but also on social inclusion and institutional coordination. Future research should therefore explore replicable models for digital inclusion, assess the socio-economic impact of digital tools in rural areas and develop frameworks that protect data ownership and ensure equitable access. Only through a coordinated, inclusive approach can South Africa bridge the digital divide in agriculture and build a more resilient, technology-enabled agricultural economy.

Policy recommendations

The following policy measures are recommended to accelerate digital transformation in the South African agricultural sector, particularly in underserved rural areas:

i. Invest in digital infrastructure in rural areas: Prioritise broadband connectivity, off-grid energy solutions and the expansion of mobile networks in agricultural regions to enable the use of digital tools and platforms.
ii. Subsidise digital technologies for SMEs: Offer financial incentives, tax breaks or equipment subsidies to smallholder farmers and agribusinesses to reduce the high upfront costs of adopting precision farming equipment, sensors and software.
iii. Promote public-private partnerships (PPP): Encourage collaboration between government, Agri-tech companies and research institutions to co-develop scalable digital solutions tailored to local agricultural conditions.
iv. Develop a national strategy for digital agricultural education: Integrate digital skills, data literacy and agricultural technology content into agricultural education curricula and community-based extension programmes, particularly targeting youth and women.
v. Establishment of innovation centres and agricultural technology incubators: Support regional centres that provide local farmers and Agri-startups with access to training, mentorship, data services and testing of new technologies.
vi. Data standardisation and interoperability framework: Develop national guidelines on data ownership, access and interoperability to ensure secure and equitable use of agricultural data across different platforms.
vii. Monitor and evaluate progress on digital adoption: Establish a national monitoring system to track digital inclusion, utilisation rates and productivity impacts in the agricultural sector to enable future policy adjustments for digital agriculture.

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