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Review Article

Digital Technology Adoption in the Agriculture Sector: Challenges and Complexities in Africa

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This article examines the trends and rates of digital technological transformation in the African agricultural sector. While the literature on digital technologies in sectors such as manufacturing, communications, tourism and hospitality, and education abounds, focus on the applicability, relevance, and adoption of digital technologies in farming, particularly by smallholder farmers in agrarian Africa, remains limited. This is a problem that can have huge scholarly and policy implications and therefore needs to be addressed, at least at an academic level. This article uses a literature review to explore the level of digitalisation in African farming, examine the contribution of digitalisation to productivity and sustainability, identify the key challenges to and drivers for digitalisation in African farming, and propose policy frameworks to strengthen the digitalisation of agriculture. The analysis reveals that there are a number of significant challenges that need to be addressed. These include resource scarcity, limited expertise and training, a lack of digital infrastructure, data privacy and security concerns, and resistance by farmers. In spite of this, the agricultural sector in Africa has the potential to adopt technology and not only boost farm productivity but also engender sustainable and environmentally friendly farming. This, however, requires the collective effort of the public and private sectors as well as communities.

1. Introduction

Digitalisation is the defining technological development of the contemporary era. Digitalisation will continue to have critical implications for agricultural sectors, particularly in the context of climate change challenges. Research shows that climate change and other emerging constraints like the recent COVID-19 pandemic which restricted movements and operations generate both direct and indirect challenges for the agricultural sector [1, 2]. These challenges require urgent attention and immediate resolution. Dominant proposals in recent years revolve around the need to go technological and digital [1, 3, 4]. Digitalisation is broadly defined as the transition to technologies that are based on the Fourth Industrial Revolution (4IR) [1, 2]. These include the Internet of Things (IoT), artificial intelligence (AI), cyber-physical systems (CPS), virtual reality (VR), and augmented reality (AR), as well as some mobile technologies, devices, and applications which can be used together with these systems [5]. In the agriculture sector, digitalisation is perceived as wielding much potential to revolutionise farming activities and to organize production and value chains [6].

In recent decades, agricultural stakeholders across the world have been increasingly promoting and transitioning to digital tools to improve their operations [2, 3, 7]. Technology adoption in the sector has been accelerated not only by climate change but also by the COVID-19 restrictions that were implemented by countries across the world [7, 8]. However, the technological transition foreshadowed by digitalisation continues to be a challenge for the African agricultural system [1, 7]. Studies that problematise this reality are only gradually emerging [4, 9]. While the literature on digital technologies in sectors such as manufacturing, communications, tourism and hospitality, and education abounds, focus on the applicability, relevance, and adoption of digital technologies in farming, particularly by smallholder farmers

in agrarian Africa, remains limited. This is a problem that can have huge scholarly and policy implications and therefore needs to be addressed, at least at an academic level. Given the benefits that technological transition could bring to the sector, policy institutions and academics continue to press for concerted efforts toward rapid technological adoption in agriculture [10, 11]. This study contributes to ongoing debates on digital technologies in farming, with a focus on Africa.

This article, therefore, reviews the literature on the digitalisation of farming in Africa so as to (i) explore the status of digitalisation in African agriculture, (ii) explore the challenges of digitalisation and technology integration in African agriculture, and (iii) propose a policy framework which African various stakeholders could use to promote digitalisation in agriculture. The research questions for the study are phrased as follows: What is the status of digitalisation in African agriculture? What challenges are being faced in digitalisation and technology integration in African agriculture? What opportunities exist for African farmers to adopt and integrate technologies into their agricultural activities?

This study has the potential to draw policy attention to the need to support and fast-track digitalisation in the African agriculture sector to deal with challenges such as climate change. The study could also be of interest to farmers who already have the means to access and finance the adoption of digital technologies but do not know their relevance and their level of benefits.

After the current introduction, the next section reviews the literature on digitalisation with a deliberate focus on the agriculture sector under two subsections. This is followed by an outline of the research methodology, the findings and discussion, and the conclusions.

2. Literature Review

The literature review is divided into two subsections. The first focuses on the components of digital technologies under 4IR. The section reviews the agricultural digitalisation literature, with a focus on Africa.

2.1. Digital Technologies in the Fourth Industrial Revolution. The term "Fourth Industrial Revolution" denotes a collection or system of devices like computers, sensors, and communication networks that are linked via the Internet to convey data without being aided by human complexity [5]. It comprises CPS, the IoT, and cloud computing [12]. The technologies that have accompanied the 4IR are described as "smart" [13]. When operating in systems, these technologies can control and influence physical processes, create a virtual replica of the physical realm, and even make decentralised resolutions. Over the IoT, CPS will interconnect, transfer, and work in partnership with people in real time [14]. In the context of agriculture, by utilising the Internet, both internal and cross-organizational activities can be harmonized to boost productivity and the distribution of products to consumers [15].

Cloud computing is a form of technology that is Internet-based. It facilitates the information that is shared between the software and hardware to be transferred to gadgets like computers [16]. According to Kovács and Husti [15], end users do not necessarily need to master the fundamentals of the "cloud" or have a specialized understanding of it or control it directly. All end users only need to be aware of the resources required and how to access the services that they require on the Internet [15]. Cloud computing is a new method to add, utilise, and exchange information technology services using the Internet. Using IoT, some sensors are connected to the Internet to operate particular programs and achieve remote control. In agriculture, cloud computing and IoT can be used to achieve focused control of machines, equipment, and staff using the Internet so as to improve production and product distribution [3].

The adoption of 4IR technologies resulted in the emergence of the "Smart agriculture," "Digital farming," and "Agriculture 4.0" concepts which all refer to the assimilated internal and external interconnection of farming operations [15]. This is when digital information is made available to all agricultural stakeholders [10]. In addition, this also means that communication with all stakeholders is also done electronically, while data transfer, handling, and analysis are, for the most part, programmed [1, 4]. According to Tripoli and Schmidhuber [17], Internet-based technologies can expedite the management of large data volumes as well as interconnection across the entire agriculture value chain.

2.2. Agricultural Digitalisation in Africa. In Africa, most of the farmers are smallholders [18]. Smallholders represent about 70% of all farmers in sub-Saharan Africa [19]. As a result, smallholder agriculture holds centre stage in the digitalisation of conservations in Africa. Baumüller and Kah [7] aver that smart technologies can, without doubt, play a major role as one of the measures to improve smallholder agriculture in Africa. Kim et al. [20] make a call that with the shift in focus in digitalisation toward the entire value chain and food sector, smallholder farmers must not be left behind in the digitalisation age. Duncan et al. [21] argue that the digitalisation of agriculture is the conduit to the transformation of smallholder agriculture in Africa. Evans [9] states that digital services are projected to transform smallholder farmers' practices by spanning information irregularity that impedes activities across the value chain.

Scholars and policies as well as research institutions highlight the value of the integration of digital technologies into the activities of smallholder farming in terms of improving productivity and operations [6, 9, 22, 23]. 4IR-based devices and applications like mobile phones, radios, computers, drones, cloud computing, and the Internet are applauded as having much potential to enable smallholder farmers to improve farm operations [6]. These technologies can be used to revolutionise smallholder farming activities such as land preparation, crop management, the sourcing of inputs, harvesting, and the management of postharvest activities, as well as marketing produce [2, 24]. Concerning smallholder farming, digitalisation services could range from simple advisory communication between farmers and experts, such as extension officers using mobile phones, to the sophisticated use of drones and satellites in farm

management [25]. In addition to boosting productivity and smoothening operations, the deployment of smart technologies within the farming activities of smallholder farmers can also improve activities by providing access to important information [4].

However, notwithstanding the transformative potential of smart technologies, for most farmers, particularly smallholders in developing countries, including sub-Saharan Africa, the access and utilisation of smart technologies have been slow and uneven [10]. This has been a result of a huge spectrum of factors which range from a lack of finance, limited government support, inadequate education and training, and poor research and development facilities to collateral challenges and cultural and social practices that resist or are reluctant to accommodate transformation [10, 22]. Some scholars also caution that to effectively benefit farmers, technologies need to be able to interrelate with their social practices because any technological revolution in farming requires the support of the people who must accept and utilise it [4, 26]. Accordingly, some scholars call for cautious deliberation of the challenges that these technologies could trigger in already vulnerable communities, such as rural areas and vulnerable regions of developing countries, for instance [2, 9]. Thus, a general understanding of the various opportunities and challenges that exist for digital transformation in the context of Africa requires the use of research methodologies that can tap and benefit from a variety of sources. The methodology used for this review article is outlined in the next section.

3. Materials and Methods

This article utilizes the critical document analysis approach in which physical documents (journals and books) were studied and interpreted so as to flag the challenges and complexities of digital technology adoption in the agricultural sector in Africa. Specifically, the article focuses on the challenges and complexities of addressing the digital divide in Africa's agricultural sector. The authors conducted a search of papers that discussed difficulties associated with the introduction of new technology in African agriculture. The key terms used were African agriculture, agricultural technology in Africa, digitalisation in Africa, and smart technologies in African agriculture. The search was done on the Web of Science, Google Scholar, Scopus, and ResearchGate, some of the leading research databases where all information is likely to be found. Using the key words, a total of 234 articles were identified. The articles were filtered again to identify articles that specifically dealt with the challenges and complexities of digital technology adoption in the African agricultural sector. A total of 176 articles were eliminated using this criterion, leaving 58 articles. The articles were further filtered to remove papers that were not written in English, and articles that were published before 2018 were excluded for the sake of recency. In the end, a total of 32 publications were identified for analysis (see Figure 1). These particular articles were the primary sources of information that informed the discussion and conclusions made in the study. Thematic data analysis was used to group the key aspects that emerged from the review into themes. A total of 13 of the articles were on the Web of Science, 9 articles were from Scopus, and 6 were from Google Scholar, while 4 articles were from ResearchGate. A summary of the identified articles is provided in Table 1. Complete details of the articles are in the list of references. The key questions to which all the articles were subjected were: What are Africa's challenges in digitalisation and technology integration in the agriculture sector? What opportunities exist for African farmers to adopt and integrate technologies into their agricultural activities?

Using the aspects observed in the literature, we derive propositions in this study which can be used as either research questions or hypotheses in future studies. These propositions are as follows:

P1. Lack of infrastructure and connectivity affects digital adoption in rural areas

P2. Limited access to technology and digital skills affects adoption by farmers

P3. Limited funding affects technology adoption in African agriculture

P4. Data privacy and security concerns affect digitalisation and technology adoption

P5. Inadequate regulatory framework in countries affects digital adoption by farmers

P6. Digitalisation and technology adoption is affected by farmers' resistance to change

4. Findings and Discussion: Challenges of Digital Transformation in African Agriculture

The findings of this review are presented and discussed under six subsections, as detailed in this section. A diagrammatic summary of the identified challenges is outlined in Figure 2 at the end of the section.

4.1. Lack of Digital Infrastructure and Connectivity in Rural Areas. Many nations in Africa struggle with issues related to a lack of infrastructure, such as Internet connectivity and electricity, which makes it difficult to implement digital technology in agricultural practices [27, 28, 56, 57]. The lack of infrastructure in Africa provides substantial obstacles to the digital transformation of the agricultural industry in several different ways, each of which can be significant in its own right [46, 54]. To begin, the absence of fundamental infrastructure in many rural areas of Africa, such as electricity and Internet connectivity, can represent a major constraint for farmers to access and utilise digital technology, such as instruments for precision agriculture and mobile applications [29]. There is a possibility that digital technologies will not perform to their full potential if users do not have access to consistent electricity and the Internet [30, 55]. This will lower the technologies' levels of efficiency and effectiveness. The second concern is the spiralling expense of everything. It may be necessary for farmers to invest in pricey power generators and satellite internet to take advantage of digital technologies; this cost may be prohibitively high for many small-scale farmers [22, 51]. The

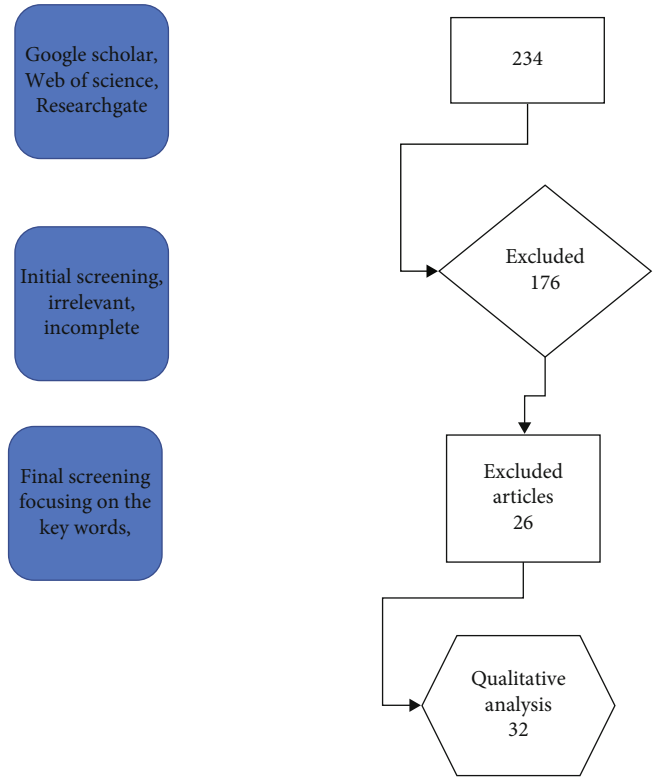

Figure 1: Article identification flowchart. Source: authors.

other problem is that farmers are unable to store data and access it when farmers need it.

The inability of farmers to collect and use data to inform their farming methods might be hindered by an inadequate infrastructure for the storage and retrieval of data, which in turn reduces the efficiency of digital technology [42, 47, 52]. Therefore, it may be difficult to scale out digital technologies across wide areas of rural Africa if the essential infrastructure is not in place. This could restrict the potential influence that these technologies could have. For example, Madichie et al. [31] investigated the opportunities and problems associated with advancing digitalisation in major economic growth areas in West Africa. According to Madichie et al. [31], one of the primary obstacles to promoting success in media-tech situations was the lack of technological infrastructure, which may be linked to low internet penetration rates. Similarly, it was found that infrastructure was a problem in situations involving the agri-tech sector [22]. Consequently, for Africa's agricultural industry to successfully undergo a digital transformation, it is essential to overcome the difficulties associated with the continent's infrastructure.

4.2. Limited Access to Technology and Digital Skills among Farmers. Smallholder farmers make up a large section of the agricultural labour in Africa [32]. These farmers may lack the knowledge and skills necessary to adequately utilise digital technologies that are available [58]. Limited access to technology and a lack of sufficient digital skills can be problematic for digital transformation efforts in the agriculture industry in several different ways. Farmers with inadequate access to technology or who do not have the skills necessary to use it are less likely to accept and utilise digital tools and services [48, 59]. Where this obtains, the spread of digital transformation is likely to slow, thereby reducing its overall impact. Farmers, who are primarily located in rural areas, do not have the skills and ability to access the technologies [47].

Furthermore, without sufficient digital knowledge and training, farmers may be unable to successfully use and gain from digital technologies, which further exacerbates the gap between access and adoption [49, 50]. Since many farmers in Africa do not have access to technology and do not have the necessary digital skills [44, 53], they are also less likely to generate and share data, which hinders the ability of the agricultural sector to make decisions based on data and to advance digital transformation [33]. This is another worrying issue. Because of the unequal distribution of technology and digital skills among farmers, some groups of farmers may gain more from digital transformation than others, which can perpetuate existing socioeconomic imbalances. For example, Kudama et al. [34] aver that despite the value of digital in overcoming challenges in farming, many of the options (mostly conceived in developed countries) are not sustainable in sub-Saharan Africa due to their lack of sensitivity to the context and circumstances of the farmers in that region.

Kudama et al. [34], however, found that many farmers do not use adaptable tools, that digitalization in agriculture in the region is unaffordable, that a significant proportion of the population is digitally illiterate, and that there is a low participation rate among women and older farmers

Table 1: List of selected articles.

Author(s)	Paper type	Publisher
[27]	Physical	IEEE Engineering Management Review
[28]	Physical	Sustainability
[29]	Personal	Africa focus
[30]	Physical	Eurasian Journal of Business and Management
[31]	Physical	Journal of Enterprising Communities: People and Places in the Global Economy.
[32]	Physical	Journal of Asian and African Studies
[33]	Physical	Springer Nature
[34]	Physical	Artificial Intelligence in Agriculture
[35]	Physical	Communications of the ACM
[36]	Physical	New Media and Society
[37]	Physical	Routledge
[38, 39]	Physical	Oxford University Press
[40]	Physical	African Renaissance
[41]	Physical	African Journal of Hospitality, Tourism and Leisure
[42]	Physical	University of South Africa Conference Paper
[43]	Physical	Journal of Economics, Finance and Accounting
[44]	Physical	Geoforum
[24]	Personal	Online
[45]	Physical	International Institute of Social Studies
[46]	Physical	Computer Science & Information Technology
[22]	Physical	FAO
[47]	Physical	Preprint
[48]	Physical	Springer Cham
[49]	Physical	MDPI
[50]	Physical	UK-RAS (Robotic and Autonomous System)
[51]	Personal	Online
[52]	Personal	Online
[53]	Physical	Int. J. Adv. Comput. Sci. Appl
[54]	Physical	Sustainability
[55]	Physical	Research ICT Africa
[56]	Physical	Trends in Food Science & Technology
[57]	Physical	Journal of the Science of Food and Agriculture

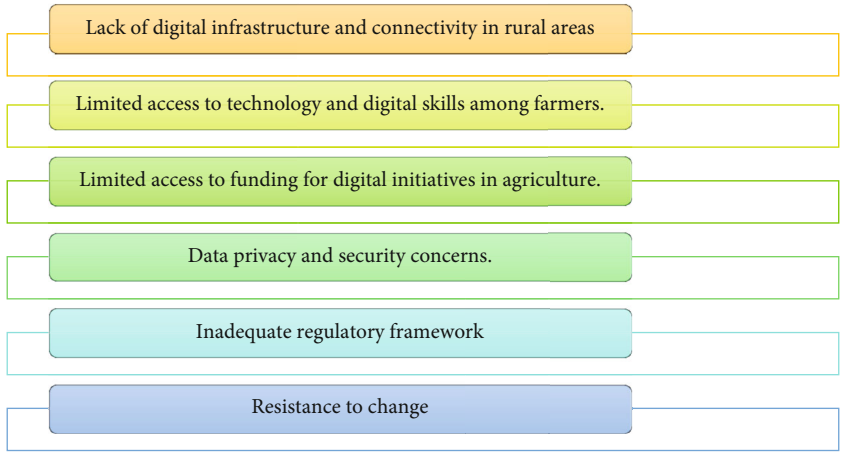

Figure 2: Summary of challenges of digital transformation in African agriculture. Source: authors.

because of their low income and educational status. Accordingly, Kudama et al. [34] state that it is essential for sub-Saharan African countries to make investments in technology that is adaptable to their population of interest by minimising the total costs of digital agricultural tools and also providing digital training for farmers.

4.3. Limited Access to Funding for Digital Initiatives in Agriculture. It is sometimes difficult for smallholder farmers to obtain finance to make investments in digital technology, which makes it tough for them to improve their operations and remain competitive [33, 35]. Similar to how restricted access to technologies can provide multiple challenges for digital transformation, poor access to money for digital and technology integration in agriculture can also be a barrier to digital transformation in several different ways [24]. It is possible that organizations and businesses operating in the agriculture sector will not be able to deploy and scale up digital technologies and solutions if enough funding is not provided. This can impede the progress being made toward digital transformation [41]. The implementation of digital technology and solutions in agriculture typically demands a large upfront investment, which can be difficult for smaller organizations and farmers with limited resources to obtain. The ability of organizations within the agricultural sector to pursue research and development activities aimed at advancing digital transformation may be hindered if there is insufficient funding allocated for digital initiatives [43]. This may also encourage excessive dependence on funding from outside sources. Because of the potential for financing objectives and sources to shift over time, the fact that organizations and businesses operating in the agriculture sector are reliant on outside funding sources can also result in a lack of stability and a lack of long-term commitment to digital transformation. Due to this, restricted access to funding can be a barrier to the creation, dissemination, and acceptance of digital technologies and solutions in the sector, thus slowing down the progression toward digital transformation.

4.4. Data Privacy and Security Concerns. In a digital realm that is mostly uncontrolled, there are worries regarding the level of privacy and security afforded to sensitive information [36, 37]. There are a few different ways in which concerns over data privacy and security can present obstacles to digital transformation in agriculture. The establishment of trust barriers is one of them. Farmers and organizations operating within the agriculture sector could be hesitant to accept digital technologies and solutions due to worries about the privacy and security of their data, which would slow down the spread of digital transformation and reduce its overall impact [43]. Another problem is that in some Southeast African nations, there may be legal and regulatory roadblocks. These are situations in which complicated and ever-changing data privacy and security regulations make it difficult for organizations working in the agricultural sector to comply with the necessary legal requirements, which in turn slows the pace of digital transformation. Again, to protect the privacy and safety of sensitive data in a world that is becoming more interconnected and digitized, it is necessary to have access to specialized technical knowledge and resources [54]. However, this can be challenging for organizations working in the agricultural sector that are already operating under resource constraints. Finally, data breaches and other security events can have major financial and reputational effects, which can dissuade firms within the agricultural sector from undertaking digital transformation efforts. These difficulties can make people in the agricultural industry less likely to have faith in digital technologies and solutions, which slows down the process of digitally transforming the industry. To address these challenges, organizations within the agricultural sector need to give high priority to the protection of sensitive data as part of their digital transformation initiatives. Additionally, these organizations need to work toward the development of robust technical and legal frameworks to ensure that sensitive data is safeguarded.

4.5. Inadequate Regulatory Framework. Barriers to adopting and using digital technology may be a result of the absence of legislation that is both explicit and supportive of digital agriculture [41, 45]. There are multiple ways in which an insufficient regulatory framework can provide a barrier to the implementation of digital transformation in the agricultural industry. It can be difficult for organizations and businesses in the agricultural sector to plan and invest in digital transformation initiatives when there is a lack of clear and concise regulations surrounding digital technologies and solutions. This can lead to uncertainty for these organizations and businesses, which can make it more difficult for them to conduct business. In the agriculture industry, innovation and forward movement can be stifled by rules that are either too restrictive or too out of date. This makes it difficult for new digital technologies and solutions to acquire momentum in the market. Again, in the absence of a transparent and equitable regulatory framework, certain organizations and businesses within the agricultural sector may be better positioned to take advantage of digital transformation, while others are left behind [45]. This perpetuates already existing disparities, and the absence of a harmonized regulatory framework across different regions and countries can make it difficult for the agricultural sector to collaborate and advance digital transformation on a global scale. Consequently, an insufficient regulatory framework can be an obstacle to the development, distribution, and adoption of digital technologies and solutions in the agriculture industry, which in turn can delay the rate of digital transformation. To address this challenge, regulatory bodies will need to collaborate on the development of regulations that are both clear and precise to support digital transformation in the agricultural sector. These regulations will also need to consider the specific requirements and difficulties of this industry.

4.6. Resistance to Change. In Africa's agricultural industry, the adoption of digital technologies may also be hampered by the persistence of traditional farming practices and general resistance to change ([38] [39]). In the agriculture industry, resistance to change can provide several challenges for the digital revolution that is currently underway. Because

the agriculture industry has a long history and well-established traditions and practices, there may be reluctance among some individuals and organizations to adopt new digital technologies and solutions that present a challenge to these conventional methods of doing business [51]. In several African countries, there is a culture of mistrust when it comes to new technologies and solutions. As a result, many farmers and rural communities in these countries may be hesitant to adopt digital technologies and solutions that they do not completely comprehend. Again, a large number of African farmers continue to rely on old practices and procedures, and they may be reluctant to adopt new digital technology and solutions that provide a threat to these conventional methods of operation.

The second significant challenge is that many farmers and organizations operating within the agricultural industry may have limited knowledge and comprehension of digital technologies and solutions. As a result, they may be hesitant to adopt these solutions due to a lack of familiarity with them or a perception of the risk associated with their use [52]. Because of the time, resources, and effort that are required to adapt to new digital technologies and processes, individuals and organizations within agriculture may be resistant to doing so because of the nature of the industry itself [49]. There is a possibility that some persons working in the agriculture sector are concerned that digital transformation would result in job losses and have a detrimental influence on the workforce, which will further fuel opposition to change. As a consequence of this, resistance to change can limit the development, diffusion, and adoption of digital technologies and solutions in the agriculture sector, thus slowing down the progress being made toward digital transformation. Education and training programs that aim to overcome resistance to change and promote the benefits of digital transformation should be given high priority by organizations operating within the agricultural sector so that they can solve this difficulty.

5. Toward Digital Transformation in Africa's Agricultural Sector

As articulated by Kudama et al. [34], there should be initiatives to be taken to ensure that the challenges related to digital transformation are dealt with. Figure 3 below outlines some of the initiatives that can be undertaken to address digital transformation challenges in Africa.

As shown in nFigure 3 above, access to technology and infrastructure is important to propel Africa's agricultural sector toward digital transformation. The continent's agricultural sector needs to have access to contemporary technology and infrastructure. It is necessary to give farmers access to the Internet, mobile devices, and other technological tools for them to take part in the digital marketplace. As shown, skill development is necessary to provide farmers and agricultural employees with training on how to make good use of available technologies. The worrying trend in Africa sometimes is that even if technology is available, some farmers cannot use this technology, so training is essential so that they will be better able to improve their work and work more efficiently by making use of digital tools and platforms that are currently available.

Figure 3: Strategies to deal with digital transformation challenges in African agriculture. Source: authors.

Government assistance should be scaled up as well for the digital transformation of agriculture in Africa to be successful. Support from governments in the form of new regulations and policies is required. This may involve providing technological enterprises with tax breaks and investing in rural infrastructure to improve connectivity. This may also include the promotion of public-private partnerships through providing incentives for collaboration. It is important for the public sector and the private industry to work together to successfully drive digital transformation in Africa's agriculture sector. While the public sector can aid infrastructure, the private sector may provide investments, technological advancements, and professional knowledge.

It is also equally important to place more emphasis on the technological needs of smallholder farmers. The digital change that is occurring in Africa's agricultural industry needs to be inclusive and accessible to smallholder farmers, as they make up the majority of the agricultural workforce. This involves making reasonably priced technology and educational opportunities available to even the most remote and rural regions. Data management is also important. Successfully achieving digital transformation in Africa's agriculture sector relies heavily on the collection and analysis of relevant data. This includes information on crop yields, market pricing, and weather patterns, all of which can be utilised to help influence decision-making and enhance farming methods. Regulating the use of technology is also critical. This involves creating regulations that are unambiguous and that encourage the adoption and utilisation of digital technologies in agriculture. Such regulations should also be able to promote the adoption of these technologies while

simultaneously protecting the interests of both farmers and consumers. The other important aspect is engaging with communities and addressing cultural and social impediments that can reduce or possibly eliminate resistance to change.

6. Concluding Remarks

This study investigated the challenges and complexities associated with the digital transformation in the agricultural sector in Africa. The critical document analysis method was used to reach this conclusion. The study found that digital transformation in agriculture on the continent faces numerous challenges but also huge opportunities for growth and development. These challenges include a lack of infrastructure and connectivity, limited access to technology and digital skills, limited funding, data privacy and security concerns, an inadequate regulatory framework in countries, and farmers' resistance to change. Despite these challenges, the agricultural sector in Africa has the potential to be converted into a successful industry that is also environmentally friendly and technologically advanced if the appropriate investments are made. The study recommends that while smallholder farmers might continue to lobby for government intervention, innovativeness is also required in terms of sources of funding so that they do not rely on the government alone to steer digitalisation and technology adoption. Farmers can also participate in joint ventures and business partnerships to increase capital injection into businesses so that they can adopt new technologies. Together, the public and private sectors can work together so that the benefits of digital transformation are accessible and inclusive for all, thereby boosting economic growth and improving the livelihoods of farmers and rural communities. This can be accomplished by working together to make it happen. Future research could focus on how the government can mobilise the private sector to engage farmers on an equal footing so as to steer the digitalisation and technological adoption agenda.

Data Availability

No underlying data was collected or produced in this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

David Mhlanga contributed to the conceptualisation, writing the original draft, and analysis. Emmanuel Ndhlovu was responsible for writing the original draft, editing, and proofreading.

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