

## Unlocking Rural Maize Seed Markets: Are Zambian Smallholder Farmers Ready for Digital Solutions?

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### ABSTRACT

Zambia is a regional seed production hub with several multinational companies operating under stiff competition. The objective of this study was to report on the readiness of smallholder farmers for digital solutions in the maize seed market in Zambia. For this reason, a literature search was conducted using Google Scholar, Boolean Logic, and Scimagojr for research publications from accredited journals and reports from sub-Saharan Africa and Asia published between the years 2020 and 2023. The results show that farmers' production and livelihood will improve when they adopt digital solutions; smartphones can be a game changer for seed companies as they can easily roll out their Apps; all the digital solutions innovations in Zambia were mobile phone-based; by addressing these aspects, the adoption digital solutions by smallholder farmers will increase; and rural poverty, illiteracy, poor infrastructure, language barriers are among top factors. We conclude that farmers' production and livelihood will improve when they adopt digital solutions, and seed companies can target the one million plus smallholder farmer market that already uses phones to access government input subsidies. This paper contributes to science because it offers opportunities for conversations on smallholder farmer digital solutions and rural market access.

**Keywords:** Digital Solutions, Rural Seed Markets, Smallholder Farmers, Unlocking, Zambia

*Manuscript received 09 May 2024; revised 24 May 2024; accepted 01 June 2024; Date of publication 10 June 2024*

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### INTRODUCTION

Agriculture in Zambia is the main source of livelihood, accounting for 85% of employment, and it is the main component of gross domestic product (about 15%) and export earnings (about 50%) (Kalinda et al., 2014). The Zambian maize seed industry is currently one of the strongest and most competitive in Sub-Saharan Africa (Smale et al., 2015; (Langyintuo et al., 2010). Zambia had 16 registered seed companies in the sector in 2012, and the main six were Seed Co., Pannar Seed (now Corteva), MRI Seed (now Synergy Seed), ZAMSEED, Kamano Seed, and Prime Agric Center (World Bank, 2012). Currently, other players include Bayer, Afri Seed,

Zambezi Seed, and Klein Karoo. Maize seed is the major agriculture export contributor to the GDP in Zambia, and the use of hybrid maize seed by smallholder farmers in the southern, central, and eastern provinces of Zambia stood at 76 percent during the 2020–2021 agricultural season (Mulenga, Kabisa, and Chapoto, 2021).

There is a problem in the Zambian seed industry because the seed companies face very stiff competition, which erodes their profitability. Despite the Zambian maize seed industry being one of the strongest and most competitive in Sub-Saharan Africa (Langyintuo et al., 2010; (Smale et al., 2015), the GDP from Zambia's agriculture industry has declined from 15.6 percent (2004) to 2.7 percent (2020), and this can be attributed to factors such as drought and COVID-19 (Mulenga, Kabisa, and Chapoto, 2021). The stiff competition in the Zambian seed sector (Langyintuo et al., 2010) is reducing the profitability of the business, and seed companies have to cut costs to survive. This situation has negatively affected the seed companies' cost of doing business, and this is because competition erodes sales volumes and profitability. The difficulty arising from this problem is that seed companies are now downsizing in order to reduce costs, thereby increasing the unemployment rate in the country.

This paper is important to smallholder farmer stakeholders such as agricultural input suppliers, rural extension specialists, rural development agents, government service providers and the whole network of Non Governmental Organizations working to improve the livelihoods of poor rural dwellers.

The smallholder farmers may not be ready to play in the digital space because the type of ICTs used by smallholder farmers may not be able to support digital adoption (Abdulai et al., 2023) and several other factors may be present, such as illiteracy, a lack of knowledge and awareness, the cost of ICTs (Izuogu et al., 2023; Mansour, 2023), low-capacity digital solution usage (Munyua, 2007), and a low mobile connectivity index (MCI) (Degila et al., 2023). There are many benefits that smallholder farmers can gain by adopting digital solutions. This benefits range from a reduction in post-harvest losses (Akinwale, Wole-Alo, & Oluwole, 2023), reducing the role of middlemen, hence reducing the cost of inputs, providing opportunities for farmers to expand their markets, improving the linkage between extension and research centers, and improving the productivity and livelihood of small-scale farmers (Izuogu et al., 2023). Digital solutions through ICTs can help smallholder farmers reduce input costs, increase the quality of food produced, increase safety and taste, have better storage facilities, improve

transport linkages, and increase collective negotiations with buyers (Kalusopa, T. (2005). The Zambian seed companies can also benefit from digital solutions by increasing their capacity to share large volumes of information at minimum cost immediately (Audu, 2022) and this the reason for gold rush in use of Apps by seed companies. Digital technologies facilitate knowledge transfer thorough extension services (Deichmann et al., 2016 in Smidt & Jokonya, 2022). For example, the Zambian farmers interact with each other, with input and output markets, and extension workers on several Facebook page called Small-scale Farmers (Farming as a Business) which currently has more than half a million members. Digital solutions improve agriculture value chain access for smallholder farmers (FAO, 2015 in Smidt & Jokonya, 2022). In agriculture, digital tools can improve access to commercial markets by positively influencing the ability to access information and overcoming spatial barriers by connecting farmers and buyers (Smidt & Jokonya, 2022). For example, Zambian smallholder farmers are able to check commodity process at Soweto market on daily Komboni radio program, while agents in Kasumbalesa boarder market created a WhatsApp group that smallholder farmers use to check commodity prices. Digital inclusion can increase productivity, resilience, and reduce the vulnerability of smallholder farmers (Quayson et al., 2020), but the full deployment of digital solutions by seed companies in smallholder rural markets depends on whether the smallholder farmers are ready to embrace digital solutions.

In his maiden speech to the first session of the 13th National Assembly after assuming office in August 2021, President Hakainde Hichilema stated that his administration will mainstream the digital revolution in national programmes in order to tap into the talents and creativity of Zambians (National Assembly of Zambia, 2021, P29–30). The President further pronounced that his government will build infrastructure to enhance connectivity and support investments in optic fibre and telecommunication facilities. The presidential speech sets the political will for digital solutions in all economic sectors of Zambia, including agriculture. Whether the Zambian seed companies will leverage this political will to digitise their sales and extension services to smallholder farmers is yet to be seen, and this literature review is aimed at answering this question. However, several agricultural mobile applications (Apps) are being built to support agricultural extension delivery and the transformation of smallholder farmers in sub-Saharan Africa (Mapiye et al., 2021) and the Zambian seed companies can take advantage of these digital innovations to access smallholder rural markets.

The purpose of this research is to investigate the readiness of Zambian smallholder farmers for digital solutions in the maize seed market. Conducting a literature review could help seed companies develop digital solutions, such as Apps, that can improve their competitive advantages and, hence, profitability.

## **RESEARCH METHOD**

To investigate the readiness of Zambian smallholder farmers for digital solutions in the maize seed market, we conducted a comprehensive literature review. Our review aimed to collate findings from primary research publications and pertinent reports from 2020 to 2023.

1. Sources: Major research publications were sourced from accredited journals focusing on the developing nations of Sub-Saharan Africa and Asia.
2. Search Strategy: We employed search engines such as Google Scholar, Boolean Logic, and Scimagojr to identify relevant articles. The search strategy involved the use of specific Boolean search strings, which were as follows:  
“digital solution” AND (“smallholder farmers” OR “Zambia” OR “Africa”)  
“digital solution” AND (“small-scale farmers” OR “Zambia” OR “Africa”)  
“digital platforms” AND (“smallholder farmers” OR “Zambia” OR “Africa”)  
“Information Communication Technology” AND (“smallholder farmers” OR “Zambia” OR “Africa”)  
“Information Communication Technology” AND (“small-scale farmers” OR “Zambia” OR “Africa”)  
“Information Communication Technology” AND (“rural” OR “Zambia” OR “Africa”)
3. Selection Criteria: After the initial search, articles conducted before 2020 were excluded from the review, which focused on current developments in the field.
4. Access to Materials: Full-text articles were primarily accessed for free via links provided by the search engines. In cases where direct access to an article was not available, platforms like Research Gate were employed, offering the option to request full texts directly from the authors.
5. Final Compilation: A total of 31 publications were reviewed, including 28 research articles, 2 working papers, and one report. Among these 28 research articles, 26 were literature review papers, 1 was an empirical study, and 1 was a case study.

## **RESULT AND DISCUSSION**

This section discusses the benefits of digital solutions to smallholder farmers, the digital solutions employed by smallholder farmers during the COVID-19 lockdown in Zambia, the digital solution tools and services used by smallholder farmers, and the factors affecting the adoption and use of digital solutions among smallholder farmers.

### **Benefits of Digital Solutions to Smallholder Farmers**

Digital solutions facilitate smallholder farming transformation because these solutions facilitate market information and agriculture value chain linkages, improve farm productivity and income, improve access to financial services, improve social well-being and risk minimization, and increase women's empowerment and inclusion (Kudama et al., 2021) and the growth of smallholder farmers entails increase in production hence increase in inputs required hence reduction in competition by input suppliers such as seed companies.

Digital solutions have the capacity to increase productivity and resilience while reducing the vulnerability of smallholder farmers (Quayson et al., 2020) hence digital solutions should be encouraged by both the government through policy interventions and infrastructure development and by private sector will can employ the digital tools.

A study was conducted by (Sekabira et al., 2023) to assess digital services as the right solution for empowering smallholder farmers from the perspective of COVID-19 experiences in Mali and Niger, and their findings were that access to and use of digital solutions could benefit smallholder farmers and farming communities by facilitating access to nutrition and agricultural information, increasing access to financial services, increasing access to insurance to better manage risk, and providing new business opportunities for smallholder farmers.

Digital solutions increase weather resilience by providing weather forecasts via SMS messages and mobile applications, such as the Mfarms program in Ghana, Kenya, Benin, Côte d'Ivoire, Senegal, and Malawi and worked together with NASA to create an App which provides updated satellite weather data for agricultural production (Sekabira et al., 2023). Unfortunately,

weather forecast services in Zambia are only provided by the Ministry of Green Economy and Environment and not via SMSs or any mobile Apps. This an opportunity that can be exploited by App creators. In Nigeria, digital solutions eliminated some roles of middlemen, allowed farmers to expand their markets, enhanced extension and research linkages, and improved the productivity and livelihood of smallholder farmers (Izuogu et al., 2023). Digital solutions can facilitate farmers' adoption of practices that save labour and input and can also facilitate farmers' linkage to buyers and logistics services, which can reduce the environmental effects of COVID-19 on collectors and supply chains (Bhuvanagri et al., 2022).

### Digital Solutions During Covid-19 in Zambia

The COVID-19 in Africa had negative impact on smallholder farmers' production as it hindered access to input and output markets (Sekabira et al., 2023) and prevented flow of latest information on agricultural markets (IFAD et al., 2021) during the lockdown period.

The 2020/2021 agricultural season in Zambia suffered the COVID-19 pandemic from production to harvesting to marketing, and production capacity decreased, while works absconded from work during lockdown. As a result, access to food became limited because of movement restrictions which resulted in an increased wastage of perishable agricultural products, and disruption of the food supply chain for imported food (Mulenga et al. 2020; Mulenga, Kabisa, and Chapoto, 2021). In Zambia, tomato farmers suffered yield losses as they could not access the market and their tomatoes were rotting on farms. The wastage harvested produce during Covid-19 lockdown happened because very few urban traders travelled to buy produce in rural areas, while some farmers feared hiring labourers during the harvesting period for fear of transmission to their families (Matenga and Hichaambwa, 2021) and the wastage could have easily been mitigated by employing digital solutions. The partial lockdowns due to Covid-19 pandemic led to a reduction in extension services which led to a further decrease farming productivity (MFL 2021).

Smallholder farmers adopted different digital solutions to ensure continued farm production, access to inputs and finances, and selling produce, among others (Sekabira et al., 2023). Therefore, digital solution adoption in the agricultural sector was accelerated by COVID-19

(Harring et al., 2020; Hassoun et al., 2023; Romero and Ahamed, 2020). Smartphone applications (Apps) became an important tool for agricultural extension during the COVID-19 lockdown (Bhuvanastri et al., 2022). Digital solutions enabled smallholder farmers to alleviate supply chain movement restrictions, and they helped systems become more adaptive and resilient (Kakderi et al., 2021).

Several digital solutions in agriculture employ robotic vehicles and drones, computers, radios, Internet services, social media, and mobile applications (Hashem et al., 2021) as a way of partly responding to COVID-19 and climate change (Sekabira et al., 2023). In Zambia, social media platforms become even more popular during Covid-19 lockdown for both social and business interactions for smallholder farmers who embraced Facebook, WhatsApp, and mobile money transactions when their movements were curtailed. Between 2015 and 2017, mobile phones were the leading digital information tool in Mali and Niger (Sekabira et al., 2023), while radio and television remain the traditional sources of digital information for smallholder farmers' communities, whose members usually gather around a single radio or TV (Sekabira et al., 2023) and the situation seems not to be very different to Zambian environment.

#### Digital Solution tools and Services used by Smallholder Farmers

Digital solutions are a vital tool for improving access to finance and the commercialization of smallholder agriculture (Mushi et al., 2022). Smallholder farmers mainly use simple devices such as mobile phones, radio, and TV as access to digital resources (Abdulai et al., 2023).

During the COVID-19 pandemic period, smallholder farmers in Taraba State, Nigeria, used mobile phones and social media platforms for sourcing farming information and communicating COVID-19 information (Audu, 2022). Even digital solutions such as drones, sensors, and climate-smart agriculture services were accessed by mobile phones to increase smallholder farmers' household resilience and minimised the negative impacts of pests, climate change, and COVID-19 (Quayson et al., 2020). In Zambia, more than pone million smallholder farmers have mobile phones which is requirement for accessing government agriculture input subsidies. During COVID-19 in Mali and Niger, accessibility to traditional digital tools such as telephone, radio, and television was aided by mobile phones, even in lockdowns (Sekabira

et al., 2023). Mobile phones have strongly enhanced financial inclusion and transactions for smallholder farmers using platforms such as MPESA in Kenya, MTNMOMO in Uganda, and Agrikore in Nigeria (Quayson et al., 2020). In Zambia, for example, smallholder farmers use mobile money platforms for daily transactions, including Airtel Money, MTN Money (Momo), Tenga Mobile Money for Atlasmara Bank, Zamtel Mobile Money, and Zanaco Express.

In SSA, Africa Goes Digital Inc. (AFGD) is developing institutions and inter-organizational synergies to help its members enhance their digital solutions for smallholder farmers by leveraging WhatsApp for communication and knowledge sharing and Twitter to share success stories and form partnerships with one another in order to execute certain development projects with governments and development agencies (Ayamga et al., 2023). In Zambia WhatsApp is widely used and accepted by low income population including smallholder farmers, while Twitter is mostly used by the few elite class.

Kirui et al., (2010) found that smallholder farmers in Kenya use mobile banking (m-banking) to access finance for agriculture businesses and concluded that m-banking enables smallholder farmers to access investment capital for farming inputs and machinery, leading to increased yield and income. In Zambia, Zambia National Commercial Bank (ZANACO) has partnered with the mobile telecommunication company, MTN to offer loans to its subscribers without asking for security. This is another brilliant example of benefits of digital solutions for smallholder farmers.

In Pakistan, farmers use digital solutions for weather forecasts, pesticide and fertiliser requirements, and application information (Mushi et al., 2022) while in Zambia, digital solutions for smallholder farmers haven't reached such levels yet.

In India, digital solutions are mostly used in providing extension services to rural smallholder farmers through ICT (Behera et al., 2015), and Sanga et al. (2014) developed an information dissemination system for smallholder farmers to access extension services through ICT. Scientists and organisations have created mobile Apps to share various crops and livestock information (Mushi et al., 2022). In Zambia, radio and T.V are traditional channels for



extension provision while Facebook and WhatsApp are modern digital solutions tools for extension provision.

In Zambia, 26 innovations were identified, out of which 12 were for Zambia and 14 were regional innovations that are implemented in Zambia, and these fall under 4 categories in descending order of use by smallholder farmers: digital advisory (17%), agri-e-commerce (14%), digital procurement (13%), agri-digital financial services (11%), and smart farming (7%) (Abdulai et al., 2023). Participation in digital services is critical for the inclusiveness of digitalization in smallholder Africa. However, farmers’ engagement with digitalization services needs further explorations due to limited empirical research on the topic. This paper thus employs a cross-sectional survey of 1565 farmers in Northern Ghana to assess the factors that affect the likelihood of farmers’ participation in digital agricultural services. We applied a polynomial regression model to show that gender, affiliations to farmer groups, access to extension services, ability to place phone calls, and ownership/access to mobile phones increase the probability of participation in digital services. Thus, farmer characteristics, digital competencies, and access to digital resources are critical in determining who participates in digitalization, essentially positioning these as critical factors to consider in scaling of digital agriculture services. We further argue that access and impacts of digitalization could be exclusive due to existing equities in the identified fundamental elements for participation, adoption, and use of digitalization. Hence, strategies sensitive to the drivers of engagement, including strengthening farmer associations/groups, increasing access to extension services, building digital skills, and scaling access to digital tools (including mobile phones), are required for inclusiveness, scaling and the long-term sustainability of digitalization for smallholders (Abdulai et al., 2023; CCARDESA, 2022). Figure 1 below shows agriculture e-commerce innovations that CCARDESA recorded.

Figure 1: Agricultural e-commerce Innovations in Zambia

<b>Name of innovation</b>	<b>Innovating company</b>	<b>Description of innovation</b>	<b>Countries in SADC</b>
AgriPredict Platform	AgriPredict Solutions	Using mobile phones to provide vital, timely and on-demand agricultural information to small scale farmers to help them manage risk. They have 10,000 are active	Zambia

AgroMate/ AgriFusion	Chartered Systems Integration	Links farmers with off takers and financial institutions. It addresses financing of farmers, aggregating orders from off takers and allocating them to farmers to plant the crop and applying Agri VAS with Artificial Intelligence for the ongoing monitoring and evaluation of the farming activities. Banks are now able to offer purchase order factoring to finance farmers with a high degree of predictability of the risk and outcomes. The data can be used for crop insurance. But the App is not validated on the ground.	Eswatini , Mozambique, Namibia , South Africa, Zambia, Zimbabwe
Alternative Exchange (trading platform) in Eastern and Southern Africa,	Escrow Group	Exchange (trading platform) in Eastern and Southern Africa, This is a registered alternative exchange (trading platform) in eastern and southern Africa. The platform enables members of the public to access financial markets using mobile phones / USSD platforms and apps to shop and choose what they want to invest in, including mobile retail bonds (Government and Corporate), securities, and commodities (piloting).	Tanzania, Zambia, Zimbabwe
eMsika	eMsika Services Ltd	An online agriculture marketplace for farmers and agro-retailers to Find, Buy and Receive farm inputs across the country. They have around 1500 registered users.	Zambia
E-Soweto	E-Soweto farmers market	A social enterprise providing live online market price information to all stakeholders in the agriculture sector. They focus on fruits and vegetables. In the vegetable market they closely monitor market prices for Tomatoes, Onions, Carrots, Cabbages, Cucumbers and Potatoes. In the fruits Market updates on Apples, Bananas, Pineapples and Watermelons. User numbers are not available.	Zambia
eVetCare Livestock eExtension	eVetCare Limited	eVetCare is an online platform that links veterinary experts and their input suppliers to farmers without ready access. The underlying principle is to make veterinary services and input accessible to all farmers available all the time (24/7). They have around 160 registered users.	Zambia
Just Fresh Group Online Market	Just Fresh Group Limited	A Food and Agro-inputs supply chain company. They have around 908 users.	Zambia
Maano Virtual Farmers Market	World Food Program	An app-based e-commerce platform where farmers' surplus and buyers' demand for crops are advertised and traded. It provides a transparent, open, and trustworthy space for smallholder farmers and buyers to negotiate fair prices and deals.	Zambia
Mulimi Apunzile	E-msika Services Ltd	From the same company as eMsika. This is an online advisory information to farmers using live and on	Zambia

		demand videos from experts, it is like a Udeemy for agriculture. They have around 900 users.	
Rovert Foods	Rovert Foods	Convenient and safe fresh and dry foods delivery service within Lusaka, Zambia.	South Africa, Zambia
Soweto Uber	Soweto Uber	This is a web shop for all groceries and food stuff in Lusaka, Zambia. Soweto Uber is linking farmers and consumers.	Zambia

Figure 1: Apps Created for Smallholder Famers in Zambia

The Farmer Input Support Program (FISP) in Zambia is a government agricultural input subsidy targeting smallholder farmers and delivering agricultural inputs through the electronic voucher (e-voucher) system. the e-voucher system was introduced in 2015 and targets 234,101 smallholder farmers using a digital platform called the Zambia Integrated Agricultural Management Information System (ZIAMIS) in collaboration with Smart Zambia (GRZ, 2022).

#### Factors affecting the adoption of digital solutions among smallholder farmers

In Ghana, the participation of smallholder farmers in digital services were negatively affected by their lack of membership in associations, poor access to extension services, farmers' digital incompetence in placing phone calls, and their low access to mobile phones, and gender imbalance (Abdulai et al., 2023). In Zambia, all smallholder farmers registered for government agricultural input subsidies belong to cooperatives as per requirement hence adoption of digital solutions by these farmers is expected to be higher.

During the COVID-19 pandemic period, the major challenge to the utilisation of digital solutions by smallholder farmers in Taraba State, Nigeria, was access to credit facilities (Audu, 2022) a situation that may not apply to Zambian smallholder farmers.

The challenges of digitalization solutions for smallholder farmers in Nigeria were a lack of technical skill, poor infrastructure, and high purchase and maintenance costs (izuogu et al., 2023), which can equally apply to Zambian smallholder farmers.

In Kenya, rolling out of digital services for smallholder farmers was hindered by a lack of digital literacy to use smartphones by most smallholder farmers; digital solutions such as digifarm would not operate in remote areas due to network inaccessibility; a lack of smallholder farmers' exposure to digital platforms, even when they could use WhatsApp on their smartphones; and the mistrust caused by scammers as smallholder farmers could not distinguish between true platforms from fake ones (Kieti et al., 2022); and inadequate information due to a lack of infrastructure, low literacy levels, a lack of suitable information services, and a lack of technical competencies (Smidt & Jokonya, 2022). This could be true in Zambia hence primary data should be collected through a research study.

In SSA, the main barriers to smallholder farmers' adoption of digital solutions were failure to use adaptable tools, unaffordability, digital illiteracy, and low participation of women and old smallholder farmers due to their low income and education status (Kudama, Dangia, Wana, & Tadese, 2021), while gender imbalance is a major challenge to the scaling and sustainability of the existing mobile applications (Apps) for smallholder farming (Mapiye et al., 2021).

In Egypt, smallholder farmers' use of digital solutions was hindered by illiteracy and the cost of ICTs (Mansour, 2023) and this may be the same with developing countries in Sub Sahara African, including Zambia.

In developing countries such as Zambia, smallholder farmers face digital inclusion challenges due to a lack of collaborations and opportunities by industry players with different perspectives, positions, and responsibilities (Quayson et al., 2020).

In South Africa, digital technology adoption by smallholder farmers were affected by low-capacity usage of digital technology and a lack of digital technology infrastructure in rural areas (Smidt & Jokonya, 2022) as well as a shortage of electricity for disseminating agricultural information among farmers (Musa et al., 2013). In Zambia, some rural areas don't have mobile phone network towers and are not connected to electricity national grid a situation that hinders the adoption and use of digital solution by smallholder farmers who live in such locations.

In Sudan, smallholder farmers faced challenges in adopting digital solutions because of low education levels, low income, cultural inertia, and the scarcity of relevant localised content in local languages (Smidt & Jokonya, 2022).

In Nigeria, smallholder farmers mainly faced challenges in using digital solutions to access marketing information because of language barrier, poverty, and illiteracy (Smidt & Jokonya, 2022). Zambia has seventy-two languages coupled with high illiteracy levels in rural area, the situation that highlights the complexities of digital inclusion of smallholder farmers.

In India, smallholder farmers faced challenges in accessing and utilising digital solution tools because of insufficient power supply, poor internet connectivity, lack of knowledge, lack of confidence in using digital tools, and a lack of training programmes (Sekabira et al., 2023).

In Mali and Niger, smallholder farmers' illiteracy is an impediment to the use of digital solutions, as such individuals are more suspicious of digital devices and unaware of the benefits digital solutions can offer, and there was a gender digital divide as smallholder farmer women were not to take advantage of digital solutions (Sekabira et al., 2023). It could be interesting to obtain primary data about the gender divide on digital solution use in Zambia, which is a Christian nation because gender inequality may be driven by religious values hence the happenings in North African Muslim countries may not apply in Southern Christian countries.

The benefits of smallholder farmers' adoption of digital solutions are that digital solutions facilitate market information and agriculture value chain linkages, improve farm productivity and income, improve access to financial services, improve social well-being and risk minimization, and increase women's empowerment and inclusion (Kudama et al., 2021). Digital solutions can increase productivity and resilience while reducing the vulnerability of smallholder farmers (Quayson et al., 2020). Digital solutions can improve access to nutrition and agricultural information by increasing access to financial services, increasing access to insurance to better manage risk, and providing new business. They can also increase weather resilience for smallholder farmers (Sekabira et al., 2023) who take crop failure risks due to global warming, reduce the role of middlemen who reduce profit margins, provide opportunities for farmers to expand their markets, improve the linkage between extension and

research stations, improve the productivity and livelihood of smallholder farmers (Izuogu et al., 2023), and reduce costs (Bhuvanansri et al., 2022). The findings from the literature above is that farmers' production and productivity can improve if they adopt digital solutions. However, service and product suppliers, such as seed companies, should motivate the smallholder farmer to adopt digital services. For example, seed companies can tie their promotions to apps. If a farmer registers on the app and buys, they then qualify for specific discounts. Government policies should support digital infrastructural development especially in rural areas that lack both telecommunication network towers and electricity, and also to encourage ICT education either through adult literacy programmes or through curriculum development for schools. On the other hand, donor agencies should continue funding digital solutions innovations. The efforts of private sector, governments and donor agencies should be coordinated to achieve better and quicker results.

COVID-19 is a driver of rapid adoption of digital solutions by smallholder farmers, especially in sub-Saharan Africa (Harring et al., 2020; Hassoun et al., 2023; Romero et al., 2020). Smallholder farmers suffered the devastating effect of COVID-19 in Africa as they were unable to access input and output markets (Sekabira et al., 2023) and obtain agricultural markets current information (IFAD et al., 2021) during the lockdown period, and this situation forced them to adopt different digital solutions to sustain their farming businesses (Sekabira et al., 2023). Smartphone applications (Apps) became an important tool for agricultural extension during COVID-19 lockdown (Bhuvanansri et al., 2022), and this was of major interest to input suppliers who can leverage on the cultural change brought by Covid-19 to start using digital solutions for their interactions with smallholder farmer markets. The finding is that smartphones can be a game changer for seed companies as they can easily roll out their apps, which can help them have access to farmers' contact details for individualised services and for quick transmission of information to their target market. Seed companies can thus grow their markets in a cost-effective way. The way of life that was adopted as cope up strategy during Covid-19 has become the new normal, the new culture. Societies are not going back to old ways of living and this comes with new opportunities and challenges. The seed companies that will introduce novel digital solutions for smallholder farmer markets will not only enjoy first mover advantage but will also have strong competitive advantage.

Smallholder farmers mainly used simple tools such as mobile phones, radio, and TV as access to digital resources (Abdulai et al., 2023). Smallholder farmers in Kenya use mobile banking (m-banking) to access finance for agriculture businesses (Kirui et al., 2010). In India, digital solutions are more about rural extension services for smallholder farmers (Behera et al., 2015). The finding is that since all the smallholder farmers on the government agriculture subsidy programme in Zambia have phones, as it is a requirement of the system, seed companies can start by targeting these more than one million farmers, even though most of them may yet migrate to smartphones. The low usage of smartphones by smallholder farmers should not discourage seed companies from pursuing digital solutions Apps because technological change happens quickly and late adopters cannot easily catch up with the market trends. The youthful and more educated Zambian population offers huge potential for digital solution usage by seed companies within a couple of years to come.

Factors influencing the digital services participation of smallholder farmers in Zambia are as follows:

1. Association Membership & Extension Services: Smallholder farmers' association memberships and access to agricultural extension services have been shown to play a significant role (Abdulai et al., 2023), and pushing for digital solutions in Zambia—where farmers already belong to cooperatives—should be relatively easier.
2. Digital Competence & Access: The ability to make phone calls, possession of mobile phones, and gender differences are critical determinants (Abdulai et al., 2023) and the Zambian smallholder farmers may be ready to go in light of these factors.
3. Financial Accessibility: Having access to credit facilities can significantly boost participation (Audu, 2022) especially on smartphone Apps hence smartphones are expensive.

4. **Infrastructure & Cost Concerns:** The presence of technical skills, infrastructural availability, and costs associated with purchasing and maintaining digital equipment are notable factors (Izuogu et al., 2023) and government information policies should solve infrastructure inadequacies.
5. **Systematic Issues:** A clear national information policy, coordinated agricultural support for small-scale farmers through ICTs, and the development of human capital and technical infrastructure are pivotal (Langyintuo et al., 2010) and Zambia has included ICT in primary school syllabi and sent ICT teachers to express training, hence the country in the right direction for digital solution inclusion.
6. **Digital Literacy and Network Issues:** Digital literacy, especially with smartphones is crucial, along with reliable network connectivity. Mistrust due to scams also slows digital participation (Kieti et al., 2022). The smallholder farmers who don't have electricity in Zambia have challenges with smartphone charging because such phones require frequent charging compared to ordinary phones.
7. **Adaptability and Demographic Concerns:** The use of adaptable tools, affordability issues, digital illiteracy, and the under-representation of women and older farmers due to income and educational inequalities (Kudama et al., 2021) affect digital solution adoption by smallholder farmers.
8. **Awareness and Cost:** low levels of education, lack of ICT awareness, and high costs smartphones play a significant role (Mansour, 2023) in digital solution adoption by smallholder farmers whose income levels are low.
9. **Gender Issues:** Gender inequalities are evident in digital service participation (Mapiye et al., 2021).
10. **Industry Collaboration:** Collaboration opportunities among stakeholders with varied perspectives are lacking (Quayson, Bai, and Osei, 2020) and the Zambian



government encourages private sector participation in economic and social development and this puts the country in right direction for digital inclusion.

11. Usage and Infrastructure: Low-capacity in using digital technology and the absence of digital infrastructure in rural areas are barriers (Smidt & Jokonya, 2022) and this is huge barrier even in Zambia.
12. Electricity and Education: Electricity shortages (Musa et al., 2013), low education levels, income disparities, and cultural resistance, compounded by the lack of localized content in indigenous languages, hinder participation (Smidt & Jokonya, 2022). In Southern Africa, load shedding and power cuts are orders of the day and this situation, together with other factors slows the adoption rates of digital solution especially by poorer and less educated smallholder farmers.
13. Language and Socio-Economic Barriers: Language barriers, poverty, and illiteracy further complicate matters (Nmadu et al., 2013 in Smidt & Jokonya, 2022). Language can be huge barrier for digital solution adoption in countries like Zambia which has seventy-two languages especially if the target population also has low levels of education to understand the official language.
14. Technical Skills: Lack of technical proficiency poses a significant challenge (Odini, 2014 in Smidt & Jokonya, 2022).
15. Confidence and Training: Confidence in using digital tools and access to adequate training programs are vital for increasing participation (Abdulai et al., 2023), and I assume these factors will diminish with time as most smallholder farmers embrace digital solutions.

Addressing these aspects can potentially enhance smallholder farmers' participation in digital services. Zambia's New Dawn government is ambitious about using digital solutions for economic and social development and announced that it will provide digital infrastructure to enhance service delivery.

Among the 28 reviewed research articles published between 2020 and 2023, all of them were conducted in West Africa, East Africa, Egypt, and India, and non was conducted in Zambia. Even when the studies were conducted in multiple Sub-Saharan African countries, they did not include Zambia. Secondly, 26 out of 28 studies involved literature review papers, while one was a case study and only one was an empirical study. Further studies should focus on obtaining primary data on digital solutions in Zambia that will anchor future studies in the field. Since the Zambian government has shown a strong political will for digital inclusion, further studies can be conducted to demonstrate the steps governments have taken in this direction.

## **CONCLUSION**

We conclude that farmers' production and livelihood will improve when they adopt digital solutions. Secondly, the beneficiaries of the government agriculture input subsidy program are required to have phones, hence seed companies can target the one million plus smallholder farmer market, even though most of the smallholder farmers do not yet have smartphones. Thirdly, the Zambian seed companies must take advantage of a strong political will to embrace digital solutions. Lastly, we discuss factors influencing the participation of smallholder farmers in digital services, and results show that rural poverty, illiteracy, poor infrastructure, and language barriers are among the top factors. This paper investigates Zambian smallholder farmers' readiness for digital solutions in the maize seed market. This paper contributes to science because it offers opportunities for conversations on smallholder farmer digital solutions and rural market access.

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