



Digitalizing the Agricultural Sector to Enhance Food Security in Africa

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Abstract

The agricultural sector is leading all economic sectors in the African continent because of its role in providing foodstuffs, employment, foreign earnings, and raw materials among others. However, the sector is characterised by traditional farming methods, inadequate qualified extension personnel, limited resources for the potential of agriculture, increasing environmental risks, due to climate change and other challenges. Recently, the African continent was identified as one of the continents with a notable improvement in technological innovations because of it is driving towards a more sustainable future. This development has been recognized with elements of addressing food insecurity in the continent. This study reviewed related studies on the role digitalization of agriculture can play in providing adequate food production in the region. The study provides a comprehensive overview of the role digital agriculture plays in food security. The study found digitalizing agriculture has the potential to boost food farming, even though, digitalization agricultural sector may likely make some percentage of manpower to lose their jobs as they can be replaced with the digital machines. The study recommends more efforts to provide infrastructure, mechanized machines, and other farm inputs and IT knowledge to the farmers. Equally, other key economic sectors should be improved and expanded so that more human personnel that may likely loose their jobs can be employed in the sectors.

Keywords: Agriculture, digitalization, farmers, food, security

JEL Classification: O14

Contribution to/Originality Knowledge

1.0 Introduction

The role of agricultural sector in ensuring and providing raw materials for industries, food security, job opportunities, poverty reduction and promoting economic growth precisely in developing countries cannot be estimated, as the continent is blessed with abundant fertile land and cheap labour. For instance, countries like Nigeria and Ethiopia, the agricultural sector is the leading sector of the economics sectors, as it employs over 70% of the labour force. Also, the sector contributes for more than 20% of GDP in Zambia and 17% in Ghana (Aliu, 2024). These emergent nations account for more than 4% of the global GDP (World Bank, 2023). However, contempt to its importance, the sector faces several hitches, such as a lack of passion from the youths, an ageing farming population, prolong traditional farming methods, challenges brought by COVID-19, drought brought on by climate change, unfavourable weather, and geopolitical crisis like Russia's invasion of Ukraine have all made these problems worse, as such contributes to increase in food prices in the region (Aliu, 2024). Though,



successive governments in the continent spent huge amount of money and implement several programs to address the sector challenges, yet, the region is accounted with many unemployed precisely youths and majority of the population cannot access food. It has stated that inadequate access to technology and digital infrastructure are part of challenges prevent Africa attaining a sustainable future. These challenges have hindered Africa to address their major challenges of development progress (Nwokolo, Eyime, Umunnakwe, & Ogbulezie, 2024).

Digitalisation is a modern upsurge of technology, and it is instrumental to economic growth (Adeleye & Eboagu, 2019). The digital economy provides a crucial function in environmental protection, improve economic development and achieves sustainable development (Su, Su, & Wang, 2021). The digital economy relies on the digital infrastructure to achieve industrial digitalization, digital industrialisation and digital governance through technological change, which improves transaction efficiency, promotes the evolution of the division of labor, and improves the efficiency of resource allocation (Han & Liu, 2022). The intelligence of machines and robotics have created profound impacts on business, governments, and society and influencing the larger trends in global sustainability (Goralski & Keong, 2020). Smart farming techniques and precision agriculture aids in enabling farmers to maximize crop yields at optimum level by improving food security and minimizing environmental impact and promoting sustainable land management practices. The use of mobile tools, automation and control systems, data processing software and web-based applications among others have molded farming methods to digital agriculture (DA) and smart farming methods have led to contribute significantly to the economic development and sustainability of food production. The DA integrates a broader variety of technological advances such as drone technology, robotics, and mobile apps to incessantly manage soil conditions and weather fluctuations to enhance field productivity and reduce operation costs (Balasundram, Shamshiri, & Sridhara, 2023). In fact, digitalisation has been playing different roles in numerous sectors (Nnanna, Jelivov, Osman, & Isik, 2020).

Since the World Bank report in in 2017 which famous that 83 million people in 45 countries were starving and majority are from developing countries with a stable population growth. UN organizations forecast rising population growth as predicts by 2050, the number might be between 8.3 and 10.9 billion(Prosekov & Ivanova, 2018). For instance, Nigeria being one of strong African country is blessed with almost 70.8 million hectares of agriculture land area, with a coastline of 853km and over 14 million hectares of inland waters. Over 70 percent of the population engage in the agriculture sector largely at a subsistence level. Food domestic demand outweighs local production, and total fish production per year is close to 1 million metric tons (313,231 metric tons from aquaculture and 759,828 metric tons from fisheries). The country, is the largest fish consumer in Africa and among the largest fish consumers in the world with about 3.2 million metric tons of fish consumed annually. Yet, Nigeria's forest ecosystems are vulnerable by rapid population growth and economic activities (FAO, 2024). Numerous programs and initiatives such as Operation Feed the Nation, Back to Land, the Agriculture Promotion Policy (APP) and Presidential Economic Diversification Initiative among others have been implemented to sustain agriculture in Nigeria. However, farming in Nigeria is characterized with high post-harvest losses, inadequate of qualified extension

personnel, low level of irrigation farming, climate change and land degradation, low technology adoption, high production cost and poor distribution of inputs, limited financing and poor access to markets among others. Yet, as at March 2021, the agriculture contributes to 22.35 percent of the total Gross Domestic Product

In fact, in general majority of developing countries farming is done by family which is mostly done on small farms, and it is unusually family labour and older generation. The showing unwillingness of younger generation to embrace agriculture as their career becomes crucial issue.

Digitalisation has been playing diverse roles in numerous fields (Nnanna et al., 2020). The adoption of digital economy has made factor sources more advanced, complicated and diversified, and the utilization and efficiency of factor allocation are improving (Jiao & Sun, 2021). The growth of the digital economy has become a new effective method to respond to the key economic sectors precisely in Africa (Adesina, 2023). Therefore, there is fear of technology and digital adoption in agriculture may likely leads to massive unemployed labour in the sector and could likely affects the crops production. This motivates this study to be conducted to analyse the role this digitalization of agriculture on food farming in Africa. Currently, the agricultural landscape in Nigeria is gradually transforming by tailoring precisely for small and large-scale farmers. These innovative technologies have revolutionized traditional farming practices, enabling farmers to achieve higher productivity, better crop yields, sustainability, and increased profitability.

2.0 Literature Review

2.0.1 Food Security Concept

This concept was attempted to define by many researchers and policy usage in a different manner since it is origin during global food crises in the early 1970s. in fact, in only two decades, there were more than 200 published writings indicating the background dependent features of the definition(Penga & Berryc, 2018). Some studies considered food security as a fundamental, connected path from production to consumption, through distribution to processing, the concept recognized in a number of domains, rather than four “pillars” (Berry, Dernini, Burlingame, Meybeck, & Conforti, 2015). The most accepted definition of food security was made by Food and Agriculture Organization FAO, (2006) annual report on food security. According to the agency food security is an overall increase in food production and production stability. The agency recognized food security from the four central pillars namely (a) food availability, (b) food access, (c) utilization, and (d) stability. In summary, food security is a state that happens when all people, at all times, have physical, social and economic access to satisfactory, safe and nutritious food that meets their nutritional needs and food preferences for an energetic and well life. Food security concept is a multidimensional with economic, environmental and social aspects (Matemilola & Elegbede, 2017). Further, Delzeit, Zabel, and Meyer, (2016) insisted that the accessibility and food supply depend not only on the ability to produce adequate and quality of food, but also on the food price level and incomes relative to these prices, as such, agricultural prices play a crucial role in food security. Thus, food is the most basic of all human existence needs. Though, so many efforts have been made in



improving the production and quality of world food supplies. However, food insecurity still remains predominant, mainly in the worldwide southern nations of Asia and Africa. African Food Security Briefs (AFSB) estimated that nearly one out of every three persons in the sub-Saharan Africa is undernourished (Matemilola & Elegbede, 2017) .

2.0.2 Digitalization Concept

Digital revolution involves the application of communication and information technologies and large-scale proliferation. The digital economy depends on the digital industrialisation, digital governance and availability of infrastructure through technological transformation, which may promotes the evolution of the division of labor, transaction efficiency and improves the efficiency of resource allocation (Han & Liu, 2022). According to Jiao and Sun (2021) the micro-level digital economy is the application of digital technology not only eases both producers and consumers to realize economies of scale, it also reduces supply and demand costs. Thus, digitalisation is a modern upsurge of technology, and it is instrumental to economic growth (Adeleye & Eboagu, 2019). Digitalisation has been playing diverse roles in numerous fields. It improves the original transaction matching efficiency (Nnanna et al., 2020). The digital economy provides an essential function in environmental protection, fosters high-quality in economic development, and achieves sustainable development (Su, Su, & Wang, 2021). Digitalisation through using Artificial Intelligence (AI) -driven techniques like remote sensors for soil moisture can be improved with the help of GPS. The machines also reduce the need for unnecessary herbicides and pesticides (Talaviya, Shah, Patel, Yagnik, & Shah, 2020). Also, AI offers innovative solutions that can enhance productivity, efficiency, and sustainability in agriculture (Olagunju, 2024). The vital feature of the digital economy lies in the application of technological innovation to all facets of economic life. Recently, the adoption of digital economy has made factor sources more advanced, complicated and diversified, and the utilization and efficiency of factor allocation are improving (Jiao & Sun, 2021). According to Adesina (2023) the growth of the digital economy has become a new effective method to respond to the key economic sectors.

2.0.3 Digitalization and Food Security

Recently, various agricultural tools and management practices have improved significantly due to digitalization of agriculture as it overcome climate risk and reduce food insecurity (Balasundram, Shamshiri, & Sridhara, 2023). Smart farming techniques and precision agriculture have become integral components of modern agricultural systems especially in areas of drone technology for crop monitoring, autonomous machinery and predictive analytics for yield optimization in U. S.A. The application of AI in agriculture Africa may have the opportunities in enhancing agricultural productivity and food security (Akintuyi, 2024). For instance, the adoption of a Precision Agriculture (PA) management system which represents the union of trends in both the advancement in traditional agriculture technology and computer technology, sensors, variable rate technology (VRT) and computer processor capabilities. While Variable Rate Technology (VRT) which is one of the utmost promises of digital agriculture provide an automated solution to the variation in agricultural fields such as water content, organic matter, soil textures and nutrient among others. Both these digitalized

agricultural brands contribute significantly to food security. Their adoption in farming activities increase food's production, quality and stability, and reduce input costs and farming's environmental degradation (Erickson & Fausti, 2021). With the current climate change which increase global warming and affect food security by providing low agricultural yields, reducing animal growth rates, and decreasing labour productivity. Digitalization agriculture which consists new scientific innovations are now mitigate the effects of climate change and decrease food production's impact on the environment (Balasundram et al., 2023).

Though, various studies were conducted in the area. However, studies like Olagunju (2024) examines the possible harnessing of Artificial Intelligence (AI) for youth engagement in agriculture in Nigeria. The study finds that AI application in Nigeria's agriculture can transform the agricultural sector. Also, the study gathered people's perceptions on how AI technologies can be successfully utilized to address various challenges faced by young farmers. In addition, AI can play a vital role in providing access to information and market opportunities. Victoria and Ph (2023) examines the role of AI in promoting environmental protection in Nigeria for sustainable development. The study found that AI is a cost-effective technology that is likely to ease mankind's activities. In addition, Akintuyi (2024) explores the advancements and applications of AI in agriculture, focusing on the developments in the United States (USA) and Africa. The study found that in the USA, precision agriculture and smart farming techniques driven by AI have become important mechanisms of modern agricultural systems. These innovations include drone technology, autonomous machinery and predictive analytics for yield optimization.

In disparity, the application of AI in African agricultural sector provides a separate set of trials and opportunities. Among the chances are leveraging AI can enhance agricultural productivity, improve resource management, and address food security concerns. Moreover, Jha, Doshi, Patel, and Shah, (2019) conducted a comprehensive review on automation in agriculture using AI. The results indicate that farming practices using AI has proved to increase the gain from the soil fertility. Balayev and Mirzayev (2022) analyse the chances and difficulties to the use of digital agricultural technologies for sustainable development in Azerbaijan. The study used 40 people representing 17 organizations, and PEST and SWOT, and multidimensional analysis methods were used. The results show that digital agro technologies have a positive impact on the agrarian entrepreneurship of youth.

Balasundram et al. (2023) made a complete survey of the earlier published works in providing a possible impact of digital agriculture technologies for ensuring food security. The study found that using digital technology in agriculture is essential to alleviate the effect of climate change and food insecurity. According to Alahmadi et al., (2022) the digitization of agriculture paves the way for new applications and new use of technology to increase the yield of crops with less utilisation of resources. The author believed that the transformation to digital agriculture would improve the quality and quantity of food for the ever-increasing human population. Raihan., (2024) present an overview of the possible impact of digital agriculture technology and practices that may mitigate greenhouse gas emissions and boost productivity while maintaining food security. In the process the study found that adopting digital technology



in agriculture is vital to alleviate the consequences of climate change and food poverty. Erickson & Fausti (2021) examined Precision agriculture (PA) to better manage crop and livestock production. The study confirms that Precision agriculture has the potential to increase productivity, improve resource allocation for inputs such as pesticides, fertilizers, water, feed, and labor, provide for more stable production, and reduce agricultural production's environmental effect. But PA is an approach that can be very different depending on farm characteristics, such as crops and livestock raised, farm size, management, as such, the adoption of PA has been slower and less uniform compared with some other agricultural innovations. Modern PA management systems are rarely implemented on small low-mechanization farms.

The Unified Theory of Acceptance and Use of Technology (UTAUT) was employed in this study. It was presented after studying eight models of technology adoption and combined into their ultimate models. The theory was synthesized by Venkatesh, Morris, Davis, and Davis, (2003) to explain and forecast user acceptance and use of IT. The was also contextualized within many technology acceptances grounds, which range from a mobile wallet and mobile learning among others. The theory recognizes four key aspects in theorizing to influence behavioral intention to use technology. These are effort expectancy, performance expectancy, social influence and facilitating conditions. The theory was proved that it could be appropriate for studying the success and adoption of information technologies as previous studies adopted similar theory in their studies (Hebbar & Kiran K B, 2020; Ronaghi & Forouharfar, 2020; Silva & Muya, 2019). Thus, this theory is related to this study considering farmers may likely accept or adopt new innovations to boost their food farming. Digitalizing food farming was regarded as technological adoption that farmers accepted to adopt for food security.

3.0 Methodology

This is a review paper. Information was sourced based on reviewed previous studies conducted in the area to explore and relate their findings in related to digitalisation and food farming.

4.0 Results and Discussion

Based on the findings from various previous studies. This study may summarize that digitalizing the food farming sector has both positive and negative impacts. The results show that in areas of detecting and analysing weather conditions, crop diseases, extension services, and quick yields harvesting, digitalizing agriculture will improve food production and provide food security in Africa. However, in areas of human labour, digitalisation of farming may likely result in many losing their jobs, as machinery such as Robotics can replace their work.

5.0 Conclusion

Digitalization revolution has been considered as an alternative means for developing countries to overcome food farming challenges such as low-yielding crops, poor farm management, soil degradation and poor labour productivity among others. However, this study found digitalizing agriculture has the potential to boost food security in developing countries, and can attract people precisely youth to embrace agriculture. The study recommends more efforts to be

doubled in providing infrastructure such as effective communication networks in the rural areas, mechanized machines, and other farm inputs, and IT knowledge to the farmers as well as to train external personnel on the role plays by digital machines in easing food farming. Also, food research institutions should be empowered to conduct more research on the role digitalization of the entire agricultural sector can play in African food production and employment, considering our contextual peculiarity. Moreover, other key economic sectors should be revamped and made to be fully active, as they can engage other human labour that may lose their jobs in agriculture due to the adoption of new innovations.

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