Harnessing Artificial Intelligence for Youth Engagement in Agriculture: Lessons from Global Practices and Prospects for Nigeria

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ABSTRACT
The demand for sustainable farming techniques is growing as the world's population rises. In light of this requirement, enlisting young people in agriculture becomes an essential tactic for guaranteeing food security, economic growth, and rural rejuvenation. Using artificial intelligence (AI) offers a viable way to empower and draw young people to the agriculture industry. This study explores the possibilities for Nigeria while providing a summary of international approaches to using AI to encourage youth involvement in agriculture. By utilizing AI technologies like machine learning, remote sensing, and data analytics, youth can access valuable insights, optimize resource utilization, and mitigate risks associated with agricultural production. In conclusion, this paper emphasizes how AI might inspire young people to pursue careers in agriculture and emphasizes the necessity of developing methods specifically designed to maximize AI's potential in Nigeria. Nigeria can set the stage for a sustainable and inclusive agricultural future by encouraging stakeholder engagement, investing in digital infrastructure, and advancing creative policies. This would enable the country's young to spearhead agricultural transformation and economic success.
INTRODUCTION

Nigeria’s agricultural sector has long been a vital component of the country's economy, providing employment opportunities and contributing to food security (Adetuyi et al., 2023). However, there has been a decline in youth engagement in agriculture, with many young people opting for other professions and this trend poses a significant challenge as the aging farming population puts the future of the sector at risk (Girdziute et al., 2022; Fasakin et al., 2022). Youth engagement in agriculture is crucial for ensuring food security, economic growth, and sustainable development, particularly in Nigeria, where agriculture plays a significant role in the economy (Osabohien et al., 2020).

However, despite the potential benefits, youth participation in agriculture has been grossly reduced due to various challenges such as lack of access to resources, limited technical knowledge, and the perception of farming as an unattractive and strenuous occupation with little reward that does not guarantee a consistent income (Maisule et al., 2023).

Over the years, the agricultural sector has undergone significant transformations, with technology playing an increasingly pivotal role in reshaping traditional practices. With the world's population expected to reach 9.7 billion by 2050, there is an urgent need to increase food production while minimizing environmental impact (FAO et al., 2021). In this context, engaging youth in agriculture is crucial, as they represent the future of farming. Harnessing AI technologies offers opportunities to make agriculture more attractive and efficient for youth, thereby addressing challenges such as aging farmer populations and rural-urban migration (Gikunda, 2024).

Despite the global momentum surrounding AI adoption in agriculture, there exists a gap in understanding how these technologies can effectively engage youth, particularly in Nigeria where agriculture plays a significant socio-economic role (Songol et al., 2021). While various global practices showcase the benefits of AI in transforming agricultural landscapes, the applicability and scalability of these approaches in the Nigerian context remain unclear (Deji et al., 2023). Additionally, challenges such as limited access to technology, inadequate infrastructure, and a lack of awareness hinder the effective implementation of AI-driven solutions in Nigerian agriculture (Ade-Ibijola & Okonkwo, 2023). Therefore, there is an urgent need to examine the lessons learned from global practices and assess their suitability and prospects for Nigeria, with a specific focus on youth engagement.

This study delves into the intersection of AI and youth engagement in agriculture, drawing insights from global practices and exploring the prospects for its application in Nigeria. By examining existing initiatives and identifying key challenges and opportunities, this research seeks to provide valuable insights for policymakers, stakeholders, and practitioners interested in leveraging AI to address the evolving needs of the agricultural sector, particularly concerning youth involvement. Furthermore, there is a growing disconnect between youth populations and agriculture, as many perceive farming as unattractive and lacking in opportunities for innovation and advancement (Girdziute et al., 2022). In this context, harnessing AI holds
promise for addressing these challenges and revitalizing youth engagement in agriculture. However, to effectively leverage AI, it is essential to understand the global practices, lessons learned, and potential pitfalls. Moreover, contextualizing these insights within the Nigerian agricultural landscape is crucial for developing tailored strategies that resonate with local needs and priorities. Therefore, this study aims to explore the following questions:

1. What are the potentials of AI for youth engagement in Nigerian agriculture?
2. What are the global practices and initiatives leveraging AI for youth engagement in agriculture, and what lessons can be drawn from them?
3. How can policymakers, stakeholders, and practitioners leverage AI to promote youth engagement in agriculture effectively?

By addressing these questions, this research seeks to contribute to the discourse on AI-driven innovations in agriculture and provide actionable recommendations for fostering youth participation and empowerment in the Nigerian agricultural sector.

1. The Potential of AI for Youth Engagement in Nigerian Agriculture

Nigeria's agriculture sector has historically faced numerous challenges, including low productivity, limited market access, and insufficient youth involvement (ElDidi et al., 2020). However, the advent of AI technologies offers unprecedented opportunities to address these issues effectively (Eke et al., 2023). AI applications such as machine learning, predictive analytics, and robotics can enhance agricultural efficiency, optimize resource utilization, and streamline operations. Engaging youth in agriculture is critical for Nigeria's socio-economic development (Dinrifo et al., 2022). With approximately 60% of the population under the age of 30, harnessing the energy and innovation of young people is essential for driving agricultural growth and ensuring food security (FFF, 2023). However, traditional farming methods often fail to attract youth due to perceived low profitability, manual labour, and lack of technological integration (FAO, 2018). AI presents a compelling solution by offering innovative tools and platforms that resonate with the digital-native generation.

Nigeria, with its vibrant youth population and a strong agricultural sector, is well-positioned to harness the potential of AI for youth engagement in agriculture. The adoption of AI can address several challenges faced by the Nigerian agricultural industry, such as low productivity, limited access to markets, and climate change impacts (Dinrifo et al., 2022). By leveraging AI-powered solutions, Nigerian farmers can improve crop yields, optimize resource utilization, and increase profitability. One area where AI can make a significant impact in Nigerian agriculture is precision farming. By utilizing AI algorithms and remote sensing technologies, farmers can monitor crop health, soil moisture levels, and nutrient requirements in real time (Eli-Chukwu, 2019). This enables them to apply inputs precisely, reducing waste and increasing the efficiency of resource utilization. Precision farming also allows for the early
detection of pest and disease outbreaks, enabling timely interventions and minimizing crop losses (Saidakhmedovich et al., 2024).

AI-powered market intelligence systems can provide Nigerian farmers with valuable insights into market trends, demand patterns, and pricing information. This allows farmers to make informed decisions about what crops to grow, when to harvest, and where to sell their produce (Javaid et al., 2023). By aligning production with market demand, farmers can optimize their revenue and reduce post-harvest losses. AI can also facilitate access to finance and insurance, making it easier for young farmers to secure loans and protect their investments (Elbehri & Chestnov, 2021).

2. Global Practices in Using Ai for Youth Engagement in Agriculture

The agricultural sector is vital for global food security, economic development, and environmental sustainability (Pawlak & Kołodziejczak, 2020). However, attracting youth to engage in agriculture has been a challenge for many countries. In response, several nations have turned to artificial intelligence (AI) as a solution to revitalize this sector and involve younger generations (Songol et al., 2021). Around the world, countries have recognized the potential of AI in engaging and empowering young farmers. Numerous initiatives and programmers have been launched to promote the use of AI in agriculture, providing youth with the necessary skills and resources to thrive in the industry (EIA, 2023). These global practices offer valuable lessons for Nigeria and other countries seeking to harness AI for youth engagement in agriculture.

The Netherlands, which is renowned for its cutting-edge agricultural methods, is one such example. The Dutch government has made significant investments in AI research and development, which have resulted in the development of AI-powered systems that maximize agricultural yield and minimize resource waste. To further prepare young farmers with AI capabilities, the Netherlands has formed collaborations and training programmers with educational institutions. In addition to drawing more young people into the agriculture industry, this all-encompassing strategy has raised sustainability and production levels overall (Dutch government, 2024). Japan is another nation leading the way in the use of AI in agriculture. Japan has resorted to artificial intelligence (AI) to solve labour shortages and guarantee food security due to a rapidly aging farming population. Japanese farmers have been able to automate several jobs, enhance crop quality, and remotely monitor farm operations thanks to the usage of robots, AI algorithms, and IoT devices. To encourage young people to pursue jobs in agriculture, the government has also promoted AI programs through financing and legislative incentives (Cheng et al., 2023).

In the United States, several initiatives have emerged to harness AI for youth engagement in agriculture. For instance, programmers such as 4-H and FFA (Future Farmers of America) have integrated AI technologies into their curricula, providing young farmers with hands-on experience in using drones for crop monitoring, AI-powered analytics for yield prediction, and smart farming techniques (Gikunda, 2024). Additionally, organizations like the
National FFA Organization have launched competitions and workshops centered around AI and precision agriculture, encouraging youth participation and innovation in the field (Storm, 2022).

Kenya has been at the forefront of leveraging AI to empower youth in agriculture. The government, in collaboration with various stakeholders, has implemented initiatives such as the Young Africa Works program, which aims to create job opportunities for young people in the agricultural sector through the adoption of digital technologies, including AI (Laban et al., 2021). Furthermore, startups like Apollo Agriculture are utilizing AI algorithms to provide smallholder farmers with personalized agronomic advice and access to financial services, thereby attracting youth to engage in farming as a viable career option (Sharma et al., 2021). Also, AI-powered solutions have been deployed to engage youth in agriculture, addressing issues such as access to market information, financial services, and agricultural extension services. For instance, the M-Shamba mobile application uses AI algorithms to give farmers real-time advice on crop management and market prices (Dinrifo et al., 2022). In addition, organizations like the Kenya Climate Innovation Center support youth-led startups that leverage AI for sustainable agriculture practices, fostering a culture of innovation and entrepreneurship among the younger population (Dickinson et al., 2023).

Furthermore, in Kenya, initiatives like the "AgriFin Mobile" project utilize AI-powered mobile applications to provide young farmers with access to critical agricultural information, market prices, and financial services. These platforms empower youth by offering real-time insights and facilitating connections with suppliers and buyers. AI is being used to tackle the challenges of post-harvest losses. By analyzing data from sensors installed in storage facilities, AI algorithms can predict crop spoilage and recommend appropriate measures to preserve the quality and freshness of harvested crops. This not only minimizes food waste but also ensures that farmers receive fair prices for their produce (Ruhode et al., 2022).

India's agricultural landscape is undergoing a digital revolution, driven in part by AI-driven solutions targeting youth involvement. Organizations like the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) have developed AI-powered mobile applications like Plantix, which enable farmers, including the youth, to diagnose crop diseases and pests accurately (Nafpo, 2022). Moreover, government initiatives such as the Atal Innovation Mission are fostering a culture of innovation among young entrepreneurs in agriculture, facilitating the development and adoption of AI-enabled solutions for sustainable farming practices. India has seen a rise in AI-enabled initiatives aimed at engaging youth in agriculture, particularly in rural areas. Projects like the National e-Governance Plan for Agriculture (NeGPA) leverage AI to provide farmers with access to agricultural information, weather forecasts, and advisory services through mobile applications and online platforms (Jhala & Dutta, 2023). Additionally, India's "Kisan Suvidha" app integrates AI algorithms to deliver personalized advisory services to farmers, including weather forecasts, crop recommendations, and pest management solutions. By
harnessing AI, this initiative attracts tech-savvy youth to agriculture while enhancing productivity and sustainability (Tomar & Kaur, 2021).

China has been at the forefront of utilizing AI to attract youth to agriculture. The country has implemented various initiatives such as smart farming, precision agriculture, and agricultural drones equipped with AI-powered sensors. For example, the Alibaba Group launched the Rural Taobao project, which connects rural farmers with urban consumers through AI-driven e-commerce platforms (Zhou et al., 2018). Additionally, Chinese startups like XAG have developed autonomous farming robots that appeal to tech-savvy youth, offering opportunities for entrepreneurship and innovation in agriculture (Elbehri & Chestnov, 2021).

The Brazilian government's investment in AI-driven precision agriculture technologies has facilitated youth engagement through platforms like "Agronow." These platforms offer data analytics and satellite imagery, empowering young farmers to make informed decisions and optimize resource utilization (Benni, 2023).

3. Lessons Learned from Successful AI Initiatives

In a world increasingly defined by technological innovation, Nigeria stands at the precipice of an agricultural renaissance, fueled by the transformative potential of Artificial Intelligence (AI). As the nation strives to empower its youth and revitalize its agricultural sector, drawing insights from successful AI initiatives worldwide becomes paramount. Through this study, Nigeria can glean invaluable lessons to propel its youth engagement in agriculture forward.

One striking revelation from global AI initiatives is the pivotal role of technology in fostering youth participation in agriculture. Countries like India, Kenya, and Brazil have harnessed AI-driven solutions to streamline agricultural processes, making them more accessible and enticing to younger generations (Owino, 2023). Whether through precision farming techniques, predictive analytics, or market intelligence platforms, AI has empowered youth to actively engage in agriculture by offering innovative solutions to age-old challenges (Dhanaraju et al., 2022). Education and awareness also play a significant role in the successful adoption of AI in agriculture. Training programs, workshops, and capacity-building initiatives should be established to equip young farmers with the necessary skills to utilize AI effectively. This includes not only technical skills but also the ability to interpret and apply AI-generated insights in practical farming situations (Gikunda, 2024). By fostering a culture of lifelong learning and innovation, countries can ensure that youth are well-positioned to take advantage of AI technologies in agriculture.

Furthermore, these initiatives underscore the importance of tailored educational programmers and capacity-building efforts. By equipping youth with the necessary skills to leverage AI tools effectively, nations have witnessed a surge in youth-led agricultural entrepreneurship (Adeyanju et al., 2021). Nigeria can emulate this approach by investing in vocational training, digital literacy programmes, and collaborative platforms that facilitate knowledge sharing and skill development among its youth. Collaboration emerges as
another cornerstone of successful AI-driven agricultural initiatives (Gikunda, 2024). By fostering partnerships between government agencies, private sector entities, research and academic institutions, and grassroots organizations, countries have created holistic ecosystems that nurture innovation and entrepreneurship (Ajayi-Nifise et al., 2024). Such collaborative frameworks not only leverage diverse expertise but will also ensure the scalability and sustainability of AI interventions in agriculture (Aderibigbe et al., 2023).

Moreover, the global landscape offers valuable insights into the importance of policy frameworks conducive to innovation and entrepreneurship. From regulatory incentives to funding mechanisms, governments play a pivotal role in catalyzing AI adoption in agriculture (Gikunda, 2024). By enacting policies that foster innovation, protect intellectual property rights, and promote inclusive growth, Nigeria can create an enabling environment for youth-led agricultural transformation. However, amidst the success stories lie important caveats and challenges (Oturu et al., 2022). Ethical considerations, data privacy concerns, and the digital divide pose significant hurdles to the widespread adoption of AI in agriculture (Mark, 2019; Ryan, 2023). Also, ensuring inclusivity and equitable access to AI technologies remains imperative to prevent exacerbating existing socio-economic disparities (Farahani & Ghasemi, 2024).

Nigeria stands at a critical juncture in its quest to harness the power of AI for agricultural transformation and youth empowerment. By drawing inspiration from successful initiatives worldwide, the nation can chart a course towards sustainable development and inclusive growth. Through targeted investments, collaborative partnerships, and forward-thinking policies, Nigeria can unlock the full potential of its youth as catalysts for agricultural innovation and prosperity.

CONCLUSION AND RECOMMENDATIONS

In conclusion, the potential of harnessing artificial intelligence (AI) for youth engagement in agriculture is immense and holds promise for transforming Nigeria's agricultural sector. By examining global practices, we have gleaned valuable insights into how AI technologies can be effectively utilized to address various challenges faced by young farmers. From precision farming to crop monitoring and pest management, AI offers innovative solutions that can enhance productivity, efficiency, and sustainability in agriculture.

Moreover, AI can play a crucial role in empowering youth by providing access to information, training, and market opportunities. Through digital platforms and mobile applications, young farmers can access real-time data, expert advice, and financial services, thereby enabling them to make informed decisions and improve their livelihoods. Additionally, AI-driven technologies such as drones, sensors, and predictive analytics can help mitigate risks associated with climate change and market volatility, enabling youth to adapt and thrive in a rapidly changing environment.
However, to fully realize the potential of AI in agriculture, concerted efforts are needed from various stakeholders, including government, private sector, academia, and civil society. Investment in infrastructure, research and development, and capacity building is crucial to build a supportive ecosystem for AI adoption among young farmers. Furthermore, policies and regulations should be developed to ensure the ethical use of AI technologies, protect data privacy, and promote inclusive access to digital resources. By implementing the following recommendations, Nigeria can unlock the transformative potential of artificial intelligence in agriculture and empower its youth to become key drivers of sustainable development and food security.

1. Improve access to reliable electricity, internet connectivity, and digital infrastructure in rural areas to facilitate the adoption of AI technologies by young farmers.
2. Allocate resources for research and development initiatives aimed at developing AI solutions tailored to the needs and context of Nigerian agriculture, with a focus on youth engagement.
3. Develop training programmers and workshops to build the technical skills and digital literacy of young farmers, enabling them to effectively utilize AI tools and technologies.
4. Establish financial mechanisms such as grants, loans, and subsidies to support young farmers in adopting AI-driven innovations and scaling up their agricultural enterprises.
5. Encourage collaboration between government, private sector, academia, and civil society organizations to co-create and implement AI-enabled solutions for youth engagement in agriculture.
6. Develop guidelines and regulations to ensure the ethical use of AI technologies in agriculture, including data privacy, transparency, and accountability measures.
7. Facilitate knowledge sharing and collaboration among stakeholders through workshops, conferences, and online forums to exchange best practices, lessons learned, and innovative ideas for harnessing AI in agriculture.

FURTHER STUDY
This research still has limitations so further research needs to be done on this topic “Harnessing Artificial Intelligence for Youth Engagement in Agriculture: Lessons from Global Practices and Prospects for Nigeria”.

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