



Leveraging on Artificial Intelligence Technology in Boosting Cassava Production in Nigeria: The Gains and Constraints

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Abstract

Artificial Intelligence (AI) technology is reshaping agricultural landscape globally by employing data-driven, efficient, and scalable production methods. Nigeria, as the world's largest producer of cassava, faces persistent challenges like low yield per hectare, pest infestations, climate variability, and inefficient farming techniques. This study focuses on the potential of AI technology to exploit and enhance the nation's agricultural potentials and productivity. The study decisively examines the application of AI in cassava production in Nigeria, focusing on its gains and constraints. It adopted ways to addressing the critical challenges like climate variability, scarce access to digital farming techniques, and the need for sustainable practices. Using a descriptive and analytical approach based on secondary data from FAO, NBS, IITA, and recent scholarly publications, the study explores AI-driven technologies such as precision agriculture, machine learning, remote sensing, and automation. Findings from the study reveal that AI technology application in cassava production can significantly improve productivity, optimize resource utilization, and reduce post-harvest losses. However, adoption can be constrained by high costs, poor infrastructure, low digital literacy, and weak policy frameworks. This paper investigates how AI technology can be employed to achieve the mass production of cassava in Nigeria, while critically examining the associated gains or benefits and constraints.

Keywords: Artificial Intelligence (AI) technology, Cassava production, Boosting production, Gains, Constraints

Introduction

The integration of Artificial Intelligence (AI) technology in boosting agricultural products is the embedding of the technology capabilities into its processes, tools, and infrastructure to achieving efficiency, innovation, and sustainability in the agriculture sector. The study clearly examines the integration of Artificial Intelligence (AI) technology in the production of cassava in Nigeria. From available records, Nigeria produces over 60 million metric tons of cassava annually claimed the National Bureau of Statistics (NBS, 2024), still its productivity is not at its optimal state. The study evaluates the AI technology applications like precision agriculture, machine learning-based disease detection, and predictive analytics. In the submission of (Adah et al, 2024), applied technologies in the boosting of cassava production include; improved varieties, approved planting times, ideal spacing, appropriate herbicide application, and mechanization. By World Bank report (2023), agriculture remains a cornerstone of Nigeria's economy, contributing approximately 20–25% to the Gross Domestic Product (GDP) and employing over 35% of the country's labor force. However, the agricultural sector in Nigeria faces multifaceted challenges that impact the nation's food security and economic stability, caused by climate variability, irregular rainfall and unexpected weather extremes, which poses a real threat to boosting crop yields, leading to financial losses for farmers, claimed Food and Agricultural Organization (FAO, 2020). Cassava also called manihot esculenta, is a main staple and industrial crop in Nigeria, among other crops cultivated in the country. Cassava holds an undeniable place in the economy of the nation due to its role in food security, industrial applications, and export potential. Despite the nation's global leadership in cassava production, Nigeria faces low yield per hectare unlike countries such as Thailand and Brazil who are also cassava producing countries. Nigeria produces over 60 million metric tons of cassava annually, accounting for about 20% of global production according to (NBS, 2024). Despite this seemingly impressive output,



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productivity per hectare remains relatively low compared to countries such as Thailand and Brazil as mentioned earlier. This discrepancy is largely attributed to traditional farming techniques or methods, limited mechanization, pest infestations, and scarce access to modern agricultural technologies such as AI in the production of cassava in the country. Chikoti et al (2022), attributed the low yield of cassava to factors including lack of quality varieties, poor soils, limited access to capital, competition for labor, pests and diseases. However, the emergence of AI technology has opened the door of opportunities to bridge the gap through data-driven farming techniques.

Artificial intelligence (AI), defined as the ability of machines to perform tasks that typically require human intelligence, has emerged as a transformative force in modern agriculture. Cassner et al (2019) as cited by Aamo et al (2021), agreed that agriculture in Africa is predicted to take the continent out of poverty if technology is properly utilized for mechanized farming. AI technologies such as machine learning, computer vision, and predictive analytics offer opportunities to optimize agricultural processes, improve yield, and enhance decision-making as in cassava production. From the result of a research carried out by Lasisi and Olufemi (2024), they claimed that the application of AI technologies in farming led to a 40% reduction in food waste with huge efficiency improvements. They also observed a 30% degree in processing time and a 25% reduction in transportation costs compared with the production without the application of AI technologies.

AI Technologies in Agriculture

1. Machine learning; is used for predictive analysis, yield forecasting, and disease detection.
2. Computer vision; enables image-based disease identification and crop monitoring.
3. Internet of Things (IoT); use sensors to collect real-time data on soil moisture, temperature, and crop health.
4. Robotics and automation; are used to automate planting, irrigation, and harvesting processes.
5. Remote sensing; is used as satellite and drone imagery to provide large-scale farm monitoring.
6. Precision agriculture; this is an AI enabled site-specific farming practices, improving soil and crop management.
7. Disease detection; is an AI-powered image recognition systems that detect cassava diseases early.
8. Yield prediction; these predictive models analyze weather and soil data to forecast output of cassava.
9. Smart irrigation; are automated systems that optimize water usage in the production of cassava.
10. Supply chain optimization; is the use of AI to improve logistics, reducing post-harvest losses.

Cassava the tropical crop

Cassava is a tropical crop that is consumed by over 800 million people globally. The crop is essential as a staple food for most livelihoods in Nigeria. Cassava's main advantages are; it is drought resistant, resilient in poor soils and can be processed into local and international products like garri, fufu, tapioca, flour, ethanol, animal feed and HQCF claimed (Kayode, 2025). And that the production of cassava by the manual method in the country has been poor as a result of diseases like cassava mosaic and brown streak, and limited access to market, agro processors, lack of extension support and the idea technology. The above challenges have brought about limit in the massive production of cassava in the nation, resulting in constraints that create reduced income for farmers and results in after-harvest losses. To ameliorate these constraints required strategic solution hence the urgency to employing AI technology in boosting the production of cassava in Nigeria. Equally, to improve productivity, disease detection, wider market access, and extension support services for sustainable and profitable cassava farming for the Nigerian cassava farmers, will make cassava farming



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appealing to the Nigerian youths in the states identified with cassava farming and encourage their active involvement for job security and reduction in jobs unemployment.

Statement of the Problem

Regardless of being the largest producer of cassava globally, Nigeria faces significant crisis in cassava production. The main issues involved are: Low yield per hectare; High post-harvest losses; Poor pests and diseases management; Limited use of mechanization vis-à-vis technology, and; The effects of inconsistent climate. These palpable observed challenges act as hindrances to the country's ability to fully develop the economic and food security potential as regards cassava production. However, the integration of AI technology presents a potential solution and a way out of the above issues, but its adoption remains a challenge and limited.

Objectives of the Study

The study aims to:

1. Examine the role of AI technology in boosting cassava production in Nigeria,
2. Identify the gains of AI technology adoption in the Nigerian agricultural sector,
3. Analyze the constraints associated with AI technology adoption and application in boosting cassava production in Nigeria,
4. Provide recommendations for the effective integration of AI technology in cassava production.

Theoretical Framework

The framework for the study is based on the technology acceptance model (TAM). The technology acceptance model explains how farmers adopt to new technologies based on their perceived usefulness and the ease of their application. In the rural areas of Nigeria, farmers' willingness to adopt AI technology in farming depends on the affordability, accessibility, and the seeming benefits. The adoption of AI technology in agriculture is influenced by awareness, social networks, and institutional support called the diffusion of innovations theory. This concerns the degree of spread of innovations within a society. AI technology integration in agriculture requires precise coordination across several systems that include; policy frameworks, production, processing, and logistics, known as the theory of systems.

Review of related literature

Key findings reveal that AI technology applications, such as predictive modeling for crop yields, Pest prevention, disease detection, and resource optimization, significantly improve farming efficiency and sustainability. Akis (2016) as cited by (Aamo et al, 2021) sees smart farming as the application of modern information and communication technologies (ICTs) skills into agriculture in order to achieve higher productivity. The research highlights the importance of tailored AI solutions that consider local agro-ecological conditions and farmer capacities. Furthermore, it identifies barriers to AI technology adoption, including data availability and cultural variability, which may hinder the widespread implementation of these technologies. The implications of this study underscore the necessity for comprehensive training programs and supportive policy frameworks to facilitate the integration of AI technology in agriculture will ultimately contribute to food security and economic stability in Nigeria. Yakubu et al (2024), highlighted the importance of tailored AI solutions that consider local agro-ecological conditions and farmers capabilities and proceeded to identify barriers to AI adoption like data unavailability and cultural variability. This research not only provides actionable recommendations for stakeholders but also contributes to the broader discourse on sustainable agricultural practices in Nigeria. The agricultural industry in Nigeria faces multifaceted challenges that impact the nation's food security and economic stability. Climate variability, marked by irregular rainfall and unexpected weather extremes, poses a significant threat to crop yields,



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leading to financial losses for farmers (FAO, 2020). Limited access to modern farming techniques exacerbates these challenges, particularly for small-scale farmers in rural areas who lack advanced machineries and efficient irrigation systems. The limited access disparity hampers productivity, perpetuating a cycle of low agricultural output and constrained economic growth opined (Ajibefun and Adejumo, 2018). Recent researches underscore the transformative potential of advanced technologies, especially artificial intelligence (AI) technology, in mitigating the identified challenges confronting agriculture in the country. AI applications such as predictive modeling for crop yields and disease detection enable farmers such as those of cassava farming to make data-driven decisions, improving efficiency and productivity claimed (Kamilaris et al., 2018). According to (Shuaibu et al., 2024), decision tree repressors, show promising results in crop yield prediction, with accuracy rates as much as 72%. While Precision agriculture techniques such as drones and remote sensing enhance productivity by optimizing resource use and enable targeted interventions, declared (Omoseni et al., 2022). Moreover, studies on renewable energy integration, such as wind turbine modeling, offer potential solutions to Nigeria's energy challenges, indirectly supporting agricultural productivity, affirmed (Babawurun et al., 2023). However, the adoption of these technologies remains limited due to the socio-economic barriers existing in the nation. Many studies focus on technical advancements, often neglecting the unique challenges faced by small-scale farmers, such as limited access to technology, training, and financial resources, confirmed (Benos et al., 2021). FAO (2023) reports that AI-driven agriculture can increase productivity by up to 25%. International Institute of Tropical Agriculture (IITA) (2022), highlights the role of digital tools in combating cassava diseases such as cassava mosaic virus. Similarly, studies show that predictive analytics improves planting decisions and yield outcomes. Global studies highlight the transformative impact of AI technology in agriculture. According to (FAO, 2023), AI-driven technologies can increase crop yields by up to 25% while reducing the input costs. The outcome of research carried out by the International Institute of Tropical Agriculture (IITA, 2022) shows that digital tools can effectively combat cassava diseases such as cassava mosaic virus and cassava brown streak disease. (Legg et al, 2024), claimed that diseases such as the cassava mosaic disease (CMD), and the cassava brown streak disease (CBSD) are the main biotic treats to cassava production in Africa. According to (UNDP, 2023) report, AI technology adoption remains relatively low due to infrastructural and economic constraints in Africa. However, pilot projects in countries like Kenya and Ghana demonstrated promising outcomes in precision farming. In the opinion of (Ogboru, 2025), the advancements in digital technologies present opportunities to enhance agricultural production among farmers in the South-West region of Nigeria and the nation in general.

Research Methodology

This study adopts a qualitative and descriptive approach using secondary data from FAO, NBS, and IITA. The content analysis was used to evaluate AI technology applications and implications.

AI Applications in Cassava Production are identified as;

1. Precision farming using drones and satellite imagery.
2. AI-based pest and disease detection systems.
3. Predictive analytics for yield forecasting.
4. Smart irrigation systems powered by the internet of Things (IoT).

Overview of Cassava value chain in Nigeria

The cassava value chain includes:

1. Production (planting and cultivation)
2. Processing into products such as; garri, tapioca, flour, starch, fufu, etc.



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3. Storage and preservation
4. Distribution and marketing

The above value-chain requires AI technologies application to boosting cassava production in Nigeria. Specifically in the main cassava-producing states that include; Benue, Kogi, Ogun, Ondo, and Delta. However, the inefficiencies across the value chain as lead to significant losses and reduced profitability for farmers in the affected states and Nigeria in general.

AI technology Applications in Cassava Production Trend in Nigeria

Year	Production(Million Tonnes)
2020	59.5
2021	60.0
2022	60.8
2023	61.2
2024	62.0

Source: NBS (2024)

Empirical Analysis (Conceptual Framework)

Artificial Intelligence refers to systems that are capable of performing tasks that typically require human intelligence. In agriculture, AI technology integrates machine learning, computer vision, and IoTs to enhance decision-making.

Hypotheses

- H₀: AI technology adoption has no significant effect on cassava production.
H₁: AI technology adoption significantly improves cassava production.
H₀: Infrastructure does not influence AI technology adoption.
H₁: Infrastructure significantly influences AI technology adoption.

Discussion

Secondary data suggests a positive correlation between AI adoption and increased productivity, though moderated by infrastructural factors.

Data Presentation and Analysis

Cassava production in Nigeria with AI technology displayed a steady growth as shown below:

Year	Production (Million Tons)
2020	59.5
2021	60.0
2022	60.8
2023	61.2
2024	62.0

However, yield per hectare remains low, indicating inefficiency rather than lack of production scale.

Table 1: Group Statistics

Groups	N	Mean	Std	standard Error
AI technology users	21	18.5	3.20	0.698
Non-AI techngy users	15	12.3	2.80	0.723

Table 2: Independent Samples Test



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Test Variable	t-value	df	Sig. (2-tailed)	Mean Difference
Cassava Yield	6.17	34	0.000	6.20

There is a statistically significant difference in cassava yield between farmers that use AI technology and the farmers that do not apply AI technology in the production of cassava in Nigeria, $t(34) = 6.17$, $p < 0.05$.

Gains of AI technology in Cassava Production in Nigeria

Some of the gains are;

1. Increased productivity; AI technology enhances yield through optimized farming practices.
2. Resource efficiency; It reduces waste of water, fertilizers, and pesticides.
3. Improved decision-making; Farmers rely on data rather than intuition.
4. Reduced losses; Better storage and logistics systems.
5. Economic growth; Boosts agri-business and export opportunities.

Constraints of AI technology in the cassava production in Nigeria

Some of the constraints are;

1. High cost; AI tools are expensive for small-scale farmers.
2. Poor infrastructure; Limited electricity and internet access.
3. Low digital literacy; Farmers lack technical skills.
4. Policy gaps; Weak government support policy for agric-technology.
5. Data Limitations; Insufficient localized agricultural data.

Discussion of Findings

While AI technology offers noteworthy benefits in all areas of life, its implementation in Nigeria must be contextualized. Unlike developed countries, Nigeria as a nation faces structural challenges that limit scalability. Therefore, a hybrid approach that is; combining traditional knowledge and modern technology is essential to boosting cassava production in the country. Hence, Nigeria as a matter of policy should implement the following;

1. Develop national AI-agriculture policies suitable for the country.
2. Invest massively in rural ICT infrastructure.
3. Provide subsidies for AI tools to boost cassava production in the country.
4. Governments and concerned agencies should strengthen agricultural research institutions across the length and breadth of the nation.

Conclusion

Artificial Intelligence (AI) technology holds a transformative potential for cassava production in Nigeria. Hence, its strategic implementation and policy support by the relevant authorities are essential to maximizing its gains or benefits to the Nigerian cassava farmers and channel for improved financial boost and bumper harvest for the nation's food security. AI technology has the potential to revolutionize cassava production in Nigeria by improving efficiency, productivity, and sustainability. Nevertheless, the success of its involvement in the production of cassava depends on addressing factors such as; the infrastructural, economic, and policy challenges confronting its massive and affordable production. Therefore, a coordinated effort involving the government at all levels, the private sector, and the farmers is essential.

Recommendations

The recommendations are offered for sustainable AI technology adoption to boosting cassava production in Nigeria. Since agriculture is the responsibility of all the tiers of government, they



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should make it a priority to invest in rural ICT infrastructure, subsidize AI technology tools, and ensure to promote agricultural digitization across the length and breadth of the country. Capacity building programs are equally essential to equip farmers with the essential skills to boost production. Hence, the need to:

1. Promote farmer education and digital training for cassava farmers.
2. Encourage public-private partnerships in the production of cassava.
3. Develop localized AI technological solutions for the production of cassava.
4. Improve data collection systems for cassava farmers.

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DOI: <https://doi.org/10.64348/zije.2026560>

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