

APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) IN ENHANCING ENTREPRENEURSHIP SKILLS AMONG FARMERS IN CROSS RIVER STATE FOR SUSTAINABLE NATIONAL DEVELOPMENT.

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Abstract

Digital technology innovations particularly in artificial intelligence (AI) have the potential to significantly benefit agriculture. Agriculture is increasingly being held accountable for ensuring food security and a source of National Development, while also taking into account environmental concerns. AI in Agricultural sector has the potential to face a continuously growing global population while also contributing to achieving the sustainable development goals (SDGS). Global agricultural systems increasingly adopt artificial intelligence (AI) for forecasting, crop monitoring, marketing and pests' detection. This study examines it relevance of AI in relation to Agricultural production, farmers perceptions of the roles of AI in agricultural production, it short coming or skepticism and development skills in agricultural production. It is recommended among others that Nigeria must focus on low-bandwidth and user-friendly. AI tools, alongside strengthening public private partnership improving rural agriculture, and developing supportive policy frame work that will improve rural infrastructure, capacity building and support for local innovation, that can significantly enhance Nigeria food security.

KEYWORDS: Artificial intelligence, Entrepreneurship, skills, Farmers, Sustainable development.

Introduction

Artificial Intelligence (AI) is a branch of computer science that enables machines to simulate human intelligence, such as learning, reasoning, problem-solving, perception and decision-making. Using algorithms, data analysis, and techniques like machines learning, AI System can perform complex tasks – such as recognizing speech, identifying images, or making prediction-that typically require human intellect Agana (2026). AI operate by processing large amount of data, identifying patterns, and using that pattern to make predictions or decisions. Through its relative learning, AI improves its accuracy and performance over time, allowing it to adapt to new inputs.

Combining artificial intelligence (AI) with farming is a revolution that increasing efficiency, precision, and decision-making based on knowledge on agricultural production and marketing. AI driven approaches like machine learning, data analytics and computer vision optimize the utilization of resources, increase productivity, and recast agricultural marketing strategies (AI-Tahaiat, Harb, AI-slaibi and Hamadnch, (2025). With the complexity of agricultural system on the rise in the contemporary period, AI-presented new answer that enable stakeholder to make decision with data, thus improving efficiency and competitiveness in the field of agriculture (Victoire, 2023). AI application in agriculture extends beyond automation since it enables predictive analytics, precision agriculture and improved marketing strategies that capture consumer patterns and market demand.

Agriculture plays a pivotal role in Nigeria's economy particularly within rural

communities, where it serves as both a primary livelihood source and a critical component of food security. The sector employs approximately 70% of the labor force and contribute about 22-25 percent to the country's gross domestic product (GDP), underscoring its centrality in national development and poverty reduction strategies (FAO 2022). However, agricultural productivity in Nigeria remains low by global standards due to a host of persistent challenges-among them are climate variability, pest outbreak, soil degradation and limited access to finance, market and timely agronomic information (Ayodele, Beatrix, Joseph, Uyochinyere, Mudashire Samson, 2025)

Agricultural advisory services are beginning to incorporate AI-driven platforms that can synthesize real-time environmental and agronomic data to provide location-specific recommendations to farmers, thus enhancing decision-making, precision and reducing risks associated with climate uncertainty (Ngozi 2022). In sub-Saharan Africa, innovative digital tools such as precision Agriculture for development (PAD), Esoko, and IBM's Agrolink are beginning to support smallholders by delivering automated message market update and crop management strategies via mobile phone and voice-based system in Local Language (Bulus, Chukwuma and Bawa (2021); Adeyemi *et al* 2025). Nigeria is not an exception to this trend. Platforms such as Zenvus and Hello Tractor have demonstrated how AI can improve productivity by equipping farmers with data on soil condition, rainfall forecasts, mechanization scheduling, and pest incidence. These platforms combine satellite imagery, sensor data and machine learning models to generate actionable insights that are both salable and cost-effective (Ojo, Adeyemo, and Adegbite, 2020; Olusanya, *et al*, 2025).

The interconnection between Agriculture, entrepreneur, artificial intelligence and sustainable National Development is therefore an area of growing academic and practical relevance. As Nigeria strive to achieve the sustainable development goal (SDGs) particularly those related to zero hunger, poverty reduction, climate action, and industry innovation. AI enable Agriculturist to offer a path way towards more efficient and equitable agricultural system (Idu *et al* 2025). However, realizing this potential depends on a nuanced understanding of how AI technologies interact with existing agricultural structure, socio-cultural norms, and institutional capacities. In particular, there is a need to evaluate whether AI-based advisory platform can truly support the multidimensional components of sustainable National Development namely human, social, natural, financial and physical capital-within rural communities. Questions persist about the appropriateness, scalability and long-term sustainability of such technologies when applied in heterogeneous farming environments with diverse crop system, market structures, and governance regimes (Yunsi, *et al* 2025).

Conclusively, concern about dependency on foreign technology providers, data privacy, and digital sovereignty require serious consideration as AI system become increasingly embedded in national food system. As such, this study seeks to provide a prescriptive blueprint for AI adoption in agriculture. It offers the extent to which AI can be integrated into Nigeria agriculture and entrepreneurship architectures in ways that genuinely promote sustainable National Development. The work again contributes to the broader understanding of how AI will enhance resource utilization, increase market competitiveness, and transform the agriculture sector into an information-minimizing one. It further clarifies the necessity of minimizing technical capabilities infrastructural constraints and ICT competencies to achieve maximum potential in AI thereby transforming the agricultural industry.

The Relevance's of AI in Relation to Agricultural production and Entrepreneurship

The key aspects of AI in agricultural production and entrepreneurship are as follows:

- ✓ **Precision Agriculture and resource optimization:** AI algorithms analyze data from soil sensors, drones, and satellite imagery to provide tailored applications of water and fertilizer, reducing wastage and lowering cost.
- ✓ **Disease and pest management:** Computer vision and machine learning models identify pest infestations and diseases early, allowing for precise, targeted spraying rather than blanket application, which boosts yield and reduces chemical use.

- ✓ **Predictive analytics and crop monitoring:** AI forecasts crop yields, optimizes planting data and predicts market demand to help farmers manage risks and improve profitability.
- ✓ **Automation and Robotics:** AI-driven robots can perform tasks like harvest, weeding and monitoring reducing reliance, on manual labor and enabling, round-the-clock operation.
- ✓ **Sustainable farming practice-** AI contribute to sustainable, agriculture, by addressing, Climate change impacts and facilitating, better land management to reduce, environmental degradation.

Farmers' perception of the roles of artificial intelligence (AI) in Agricultural production and entrepreneur

Farmers and entrepreneur generally hold a moderately favorable to positive attitude toward the role of AI in agricultural production, recognizing its potential to enhance productivity, precision, and sustainability (Sulaiman,2024). While optimistic about the benefits like better weather forecasting and pests' detection, they often express caution regarding high implementation cost, technical limitations and the reliability of AI recommendation. Some key perception on the role of AI is as follow;

- ✓ **Decision support and optimization:** Farmers view AI as a valuable tool for improving decision-making, particularly in organizing input resources like water, fertilizers, and pesticide
- ✓ **Predictive capabilities:** There is a positive outlook on AI's ability to forecast weather patterns and predict potential diseases or pest infestations, allowing for proactive, rather than reactive, management
- ✓ **Efficiency and labor:** AI is perceived beneficial for tackling labor shortages through automation e.g. Harvesting robots, autonomous tractors though some farmers are skeptical about the full extent of labor reduction.
- ✓ **Transformation of roles:** Farmers see a shift in their roles from manual labors to managers and supervision of AI-enabled, data-driven system.

Short coming or skepticism of artificial intelligence (AI) in relation in Agricultural production and entrepreneur

Artificial intelligence (AI) adoption in Nigeria agriculture faces critical bottle necks, primary high cost of digital tools, poor internet connectivity, and low digital literacy among small holder farmers. These challenges, combined with inadequate infrastructure and lack of technical skills, hinder the implementation of smart farming, pest detection and predictive analytics.

1. **High Cost:** The high initial investment in AI infrastructure (sensors, drones, smart machines) is a major barrier, particularly for smallholder farmers and entrepreneur
2. **Technical limitation and data:** Concerns exist regarding the reliability of AI, the need for high quality data, and the potential for biased recommendation if not calibrated for local conditions.
3. **Digital Literacy and infrastructure:** limited digital literacy and poor internet connectivity in rural across inhibit adoption
4. **Loss of traditional knowledge:** Some farmers fears that over-reliance on AI could diminish traditional farming expertise.
5. **Data privacy and ownership:** There is anxiety over who owns the data generated on the farm and whether it could be used against them by insurance or technology.
6. **Policy and ethical issues:** Lack of comprehensive policies governing AI, combined with data privacy concerns.
7. **Infrastructure and financial constraints:** The high cost of acquiring AI enabled devices (drones, sensors) and poor rural internet connectivity.
8. **Socio-economic hurdles-** High levels of illiteracy and resistance to adoption new technologies among rural farmers
9. **Loss of jobs due to automation:** The adoption of automation in agriculture using AI is

becoming a reality. This is due to population projection mode that proved by the year 2050 (Olaitan, Bamidele, Joel, Elleke, Joel and Sennuga, 2025). As the world population continue to grow, there is need to increase food production by adopting AI, which is an intelligent, autonomous machinery for carrying out agricultural tasks essential to improve the quality and quantity of food production level.

The prospects of artificial intelligence in relation to Agriculture production and Entrepreneur

First and foremost, of the prospect of AI in Nigeria is the increase high yield crop production. So often, the majority of the farmers in Nigeria were scattered around the rural areas, who depends mostly on weather vagrancies to produce. However, whenever there are shortages of rainfall or insects' attacks on the produce, the farmers become disadvantaged as they lack the necessary knowledge on how to track such threats and unfortunately, they may end up having little or loss produce (Idu, Sennuga, Owoicho, 2025). Although attempt have been made in this direction by some Nigeria Aristech startups leveraging AI by providing farmers with access to agricultural knowledge, advise services and other precision farming tools, in this effort, as famers who adopted such technologies were able to triple their crop production and minimize end of season harvest crops lost (Sulaiman, 2024).

Again, adopting AI in agriculture facilitate energy harvesting. With this innovation in AI, the devices produced provided a sustainable solution to power machines using renewable energy and sunlight which are environmental friendly (Uddin *et al.* 2024) one advantage of energy harvesting technology of AI is that such devices can operate long hours without the need to check for refueling, and they do not release carbon to the environment which ensures greener and monitoring and response to any critical issued on time.

Entrepreneurial development skills in Agriculture for sustainable National Development

Entrepreneurial development skills in agricultural production involve equipping farmers and agribusiness owners with the capacity to innovate, manage risks, and transform traditional farming into profitable, sustainable business ventures. Key skills include, but are not limited to, technical expertise (crop/fish farming, mechanization), financial literacy, risk management, and strategic marketing.

The necessary skills for agric-prenurs include:

- ✓ **Technical and production skills:** Knowledge of modern crop farming, fish farming, poultry management, and snail rearing.
- ✓ **Business Management skills:** Ability to create business plans manage resources (7. MS: Manpower, money materials, machines, methods, markets, management), and handle financial records.
- ✓ **Marketing skills:** Understanding market trends, value addition, and identifying new consumer demands
- ✓ **Risk management:** Ability to manage risks associated with environment changes and market fluctuations.
- ✓ **Soft skills:** Leadership, communication, decision-making and critical thinking.

Role of entrepreneurship in Agriculture

- ✓ **Increased productivity:** Entrepreneurial skills enhance the ability of farmers to adopt new technologies and improve production efficiency
- ✓ **Value addition:** Transforming raw agricultural products into higher-value items to increase profitability
- ✓ **Job creation:** Developing agribusiness reduces reliance on traditional, subsistence farming and creates jobs for rural youths
- ✓ **Sustainability:** Encouraging the adoption of sustainable farming methods that ensure long-term profitability.

Strategies for Developing these Skills

- ✓ **Agricultural Education/Extension Services:** Integrating entrepreneurship training into agricultural curriculum at schools and providing training through extension officers
- ✓ **Cooperative formation:** Promoting the formation of cooperatives to help farmers pool resources and access markets
- ✓ **Financial support:** Providing access to capital and funding for agricultural start-ups.

Conclusion

The integration of artificial intelligence (AI) in Nigeria agriculture holds transformative potential to revolutionize the sector from traditional, labor-intensive practice to high-tech data-driven system that can significantly improve productivity, enhance food security, and optimize resources use. While AI adoption is still in its nascent stages, it presents a critical pathway to bridging the 76% yield gap for many crop and tackling challenges such as pest infestation, climate change, and high post-harvest losses. Despite high potential, adoption is hindered by inadequate infrastructure (power and internet), high cost and a lack of technical expertise. The future of Nigeria agriculture depends on a coordinated approach involving government policy and private sector investment. Recent initiative, such as the Nigeria Agricultural Intelligence platform launched by Federal Government aim to onboard 5 million farmers and digitalize research outputs to enhance competitiveness. The success hinges on developing localized, low-bandwidth and affordable AI solution tailored to the specific need of smallholder communities.

Recommendations

AI-driven techniques can significantly increase production efficiency and despite high initial costs, provided long-term benefits in sustainability and profitability. For effective adoption of the AI in agricultural production, it is however recommended thus;

- ✓ Implement AI-Powered sensors and drones for real-time monitoring of soil moisture, nutrients level and crop health to optimize irrigation and reduce chemical usage.
- ✓ Use machine learning model for early disease detection, pest outbreak predictions, and accurate yield forecasting to reduce crop loss.
- ✓ Deploy autonomous tractors, robots and drones for tasks like precision seeding, spraying and harvesting to mitigate labor shortage.
- ✓ Utilize AI to analyze soil data and climate projection to choose the best crop varieties, improving resilience and productivity
- ✓ Invest in digital public infrastructure and provide training to farmers especially in low-income region to ensure equitable access and effective use of AI tools.
- ✓ To reduce its full potential, Nigeria must focus on low-bandwidth, and user-friendly AI tools, alongside strengthening public private partnership improving rural infrastructure, and developing supportive policy framework.

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