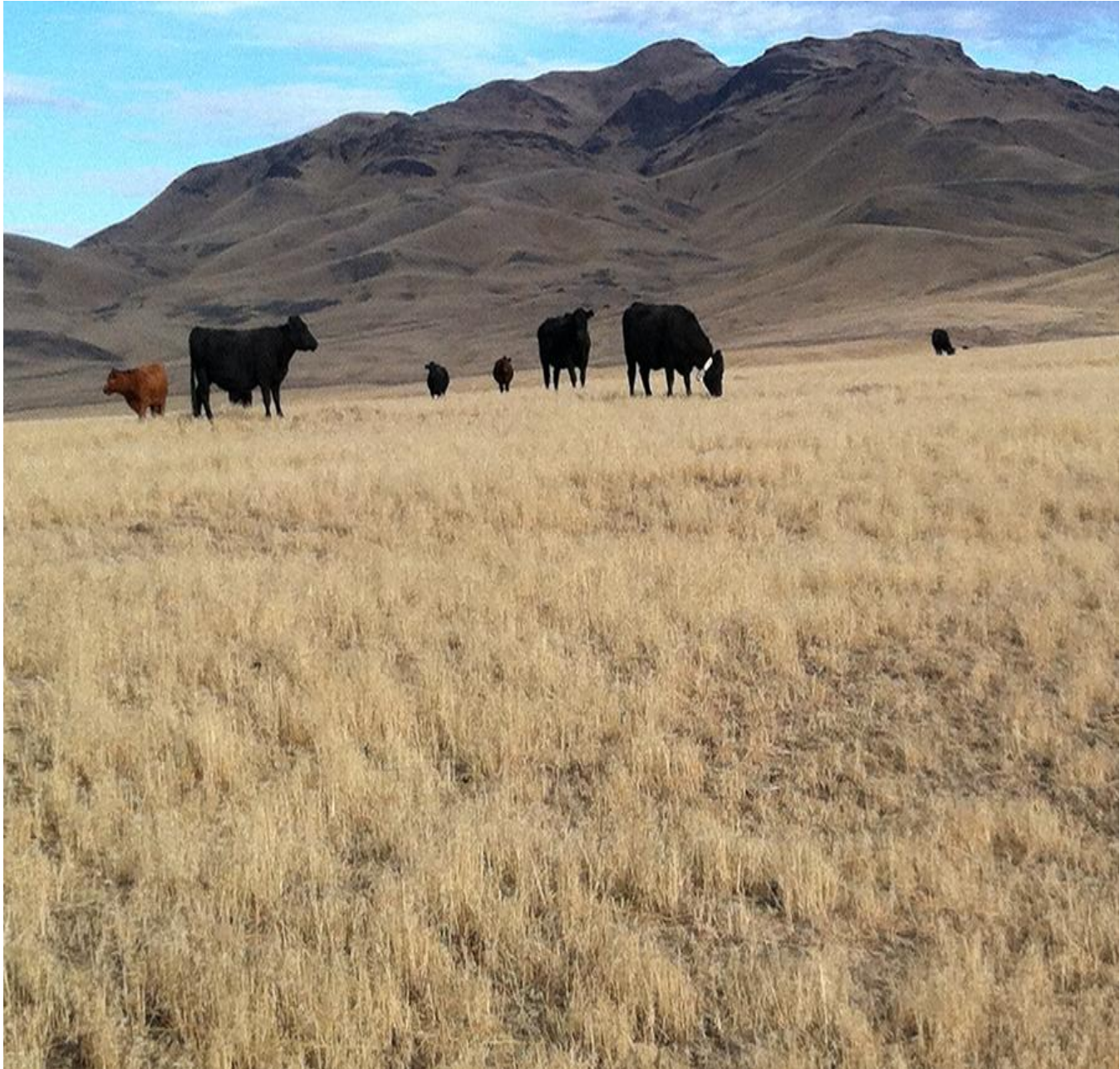


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Review Article

Challenges and Prospects of Incorporating Artificial Intelligence and Technology in Nigeria's Agriculture

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ABSTRACT

Agriculture has been the mainstay of Nigeria's majority population as it is self-generating and self-sustaining, and it continues to provide food and material needs for human sustenance. Over the years, agricultural production has continued providing some opportunities for food production, employment opportunities, and a source of livelihood. In Nigeria, agriculture continues to face some challenges: food crisis and insecurity due to global population increase, environmental degradation, prevalence and persistence of pests and diseases, low level of improved farming techniques, and lack of capital investments. However, contemporary scientific revolutions in Artificial Intelligence and Technology (AI&T) have, no doubt, transformed Nigeria's agricultural production from traditional practices to modern agriculture, which led to high yields output, early detection of pests and diseases on plants and animals, optimization of farming practices, and weather prediction, among others. The development of AI&T and its eventual incorporation into agriculture has addressed some of the challenges facing the agricultural sector in Nigeria. Notwithstanding, problems continue to surface in the form of poor technical knowledge of AI&T, illiteracy among rural farmers, high cost of AI&T adoption, poor data management, and loss of agricultural-related jobs and opportunities due to automation. This research seeks to analyze how the integration of AI&T could be used to harness the agricultural potentialities of Nigeria, whereas the data used in this research were primarily secondary sources derived from the academia, United Nations Food & Agricultural Organization (UN/FAO), and other research institutions, including universities. For clarity, questionnaires were administered for data analysis and interpretation.

Keywords: Agriculture, Nigeria, AI&T, Challenges, and Prospects

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INTRODUCTION

Nigeria, a country located on the West African continent, is bordered to the north by the Republic of Niger, to the west by the Benin Republic, to the east by Cameroon and Chad, whereas to the southern part,

it is bordered by the Bight of Benin and the Atlantic Ocean. This strategic location of Nigeria made it suitable for human habitation, with 923,000 square kilometers of landmass. Different weather and climatic conditions in Nigeria are Sahel Savannah, Sudan Savannah, Guinea Savannah, Tropical



rainforest, and swampy areas spread across the northernmost parts, the north, central areas, southern region, and the riverine areas, respectively. With such a vast landmass and different weather and climatic conditions, agriculture has emerged as the dominant economic activity throughout the country for many decades, providing food and other needs to support other industries like cloth making and tannery. Over the years, despite the country's available lands and resources, the country continues to fall short of food and other agricultural material needs. These were attributed to weather fluctuations in terms of uneven rainfall distribution, pests and diseases of crops and animals, loss of soil fertility, and unprecedented population increase, which have resulted in rising food imports and a decline in attaining food security – which sets forth malnutrition among the children, and for adults hunger set in. In order to avert such catastrophic effects on the populace, the Nigerian government had on several occasions rolled out plans and programs to tackle the issues; some of the programs rolled out to tackle such issues include Operation Feed the Nation (OFN),¹ Green Revolution (GR),² and the Anchor Borrower Program (ABP) of the Central Bank of Nigeria.³ These programs in agriculture by the state were influenced by the view that private traders are exploitative and that marketers could not be trusted with the critical task of feeding the nation and, at the same time, providing a lasting solution to the lingering food crisis.⁴ Even though the aforementioned efforts were geared towards ameliorating the problems and challenges of agriculture in the country, not much progress was achieved according to the results presented. Problems

as regards the operation of the said rolled-out programmes were identified as corruption, lack of political will and commitment on the part of the leaders, shortages of funding, and non-involvement of experienced partners like the Food and Agricultural Organization of the United Nations (UN/FAO), and the World Food Programme (WFP) to mention a few. Therefore, due to such problems and many more, the programs fail repeatedly at different levels to the extent that realizing the programs' objectives remains distant.

Amidst the agriculture crisis in Nigeria, artificial intelligence technology, the intelligence of a computer machine that enables it to imitate or mimic human capabilities, was developed, and the Nigerians embraced this development.⁵ In this sense, AI&T uses multiple technologies that equip machines to sense, comprehend, plan, act, and learn with human-like levels of intelligence. Moreover, AI&T can revolutionize agriculture and other businesses based on data analysis and outcomes. Lastly, the system uses its assessment to adjust input data, rules, algorithms, and target outcomes.⁶ So, through the use of AI&T, the problems in Nigeria's agriculture could be analyzed using the input data available, and at the same time, the application of AI combined with other technologies (mechanics and automation) which the system uses in its analysis of data could be relied upon with a high degree of reliability to project the outcomes as processed by AI&T in respect to any information/data inputted. The process of information analysis continues by assessing the problems until the desired result is achieved. So, based

¹ G. Williams, et. al. (eds.), *Rural Development in Tropical Africa*, Palgrave: Macmillan UK, 1981

² N. Ikenna, *The Green Revolution in Nigeria, or, The Modernization of Hunger*, Indiana: Zim Pan Indiana University, 1985

³ A. Coker et al., Assessment of Implementation of Modalities of the Anchor Borrowers Program in Nigeria, in *Agro-Science*, vol. 17, no. 1, Pp. 44

⁴ O. Linus et. al., 'The Role of Agricultural Market Reform in Enhancing Farmers Income in Nigeria', in *Journal of Marketing Management*, Vol. 6, No. 3, 2014, Pp. 27-32

⁵ V. Kanade, *What is Artificial Intelligence (AI): Definition, Types, Goals, Challenges, and Trends in 2022*, Available at www.spiceworks.com/tech/artificial-intelligence/article/what-is-ai/ Accessed 12/12/2024

⁶ V. Kanade, *What is Artificial Intelligence (AI): Definition, Types, Goals, Challenges, and Trends in 2022*, Available at www.spiceworks.com/tech/artificial-intelligence/article/what-is-ai/ Accessed 12/12/2024

on data input and proper analysis by AI&T, discoveries determine the outcome of the tasks assigned, which were the goals of incorporating AI&T. So, finally, introducing this technology solved many agricultural-related problems in Nigeria, albeit with some drawbacks.

CONCEPTUAL CLARIFICATION

Definition of Artificial Intelligence and Technology (AI&T)

There has been much debate about what Artificial Intelligence technology means. Alan Turing, the father of AI&T, defined it as the science and engineering of making intelligent machines and brilliant computer programs.⁷ From the above definition, one could conceive that the scholar stated the disciplines on which intelligent machines using AI&T could be produced without giving details as to how. Therefore, such a view is incomplete and ambiguous to many.

Another definition proposed by Rich Elaine (a computer scientist) is the study of how to make computers do things that people are better at or would do if they could extend what they do to a worldwide web-sized amount of data and not make mistakes.⁸ Elaine's proposition regarding AI&T was also scientific in its approach, as it contains key concepts as 'worldwide web-sized'; these words were, to some extent, capable of being comprehended by those in science and mathematics/logic disciplines. For other disciplines in humanities and arts, such keyword concepts as used in the definition above need clarification to grasp the intended meaning ascribed to them in the definition of AI&T.

Another definition proposed by Kaplan and Heinlein is AI&T, which is a system's ability to correctly interpret data and use that learning to achieve specific

goals and tasks through specific adaptation. This definition sounds flexible, as it provides a vivid and clear guide of what AI&T is set to achieve using the input (data) concerning a particular task.⁹

So, from the above definition attempts, it could be deduced that by incorporating AI&T in Nigeria's agriculture—by analyzing data regarding problems and using the same AI&T—there would be prospects for addressing the problems that continue to threaten agriculture and humanity.

Problems of Incorporating Artificial Intelligence Technology in Nigeria's Agriculture

There are a lot of problems and issues when discussing the incorporation of artificial intelligence technology in Nigeria's agriculture; although efforts were made to overcome some of the challenges, not much success was achieved. Hereunder discussed are some of the problems, which include:

- **Illiteracy among Farmers:** As it is, the literacy level in Africa and Nigeria, in particular, is very low compared to other countries on other continents. So, it is difficult to persuade farmers to understand how introducing new technologies and scientific breakthroughs could revolutionize their farming methods and techniques. Moreover, it requires many human and otherwise resources to stage public enlightenment campaigns and programs to achieve a certain level of awareness and educate Nigerian farmers to switch to new farming techniques. Another problem regarding illiteracy among Nigerian farmers was that some machines or concepts produced for agricultural use come with a manual, a step-by-step simple guide on how a machine

⁷ M. Pelicelli, 'Artificial Intelligence', in *The Digital Transformation of Supply Chain Management, 2023* Available at www.sciencedirect.com/topics/social-sciences/artificial-intelligence Accessed 12/12/2024

⁸ M. Pelicelli . . . Ibid

⁹ M. Pelicelli . . . Ibid.

could be assembled, used, and maintained in case of wear, tear, damage, or other faults. For instance, advanced tractors, agricultural machines, and other equipment used in modern-day agriculture were not like those in the old days. In today's world, all the information required to operate any machine is included in its manual, which explains in detail using the most straightforward language and diagrams to acquaint users. The sad part about farmers' illiteracy is that the percentage of those in the agricultural sector are rural people who do not have the opportunity to attend formal school or adult education classes. Therefore, introducing new machines and modern farming techniques that require reading skills for optimal usage is untenable. With the majority of the population in Nigeria being farmers living in rural areas, the introduction of basic literacy skills would no doubt enhance production capacity and knowledge-based agricultural practices.¹⁰

- Problem of Technical Know-How: Lack of technical know-how impedes the adoption of AI&T in agricultural production. This is so because the application of AI&T in agriculture requires not only the essential knowledge and skills to adopt but also technical expertise and training in computer applications usage to get the desired results. Therefore, the sector continues to lag due to the scant nature of computer experts who apply AI&T in agriculture. This was among the reasons for low production records and poor data gathering for onward results required to enhance production and monitor decreases or declines due to suspected

salient reasons, which are hard to notice simply by mere daily observations. Moreover, many farmers are still uncertain about the expected benefits and have concerns regarding the maturity and reliability of AI&T when implemented, coupled with shortages of professionals to handle the AI&T gadgets and tools.¹¹

- High Cost of AI&T Adoption: The Technology we have today costs a lot to implement, especially the computer-based technologies that use AI&T. In Nigeria's case, most of the computer gadgets were produced elsewhere and imported into Nigeria. So, the cost of importing and installing AI&T gadgets in Nigeria in agriculture is high compared to other countries where such gadgets have been adopted. Though efforts have been made to produce some of the components locally, the majority of the parts are still being imported into Nigeria, and the fact that - the local currency (Naira) is tied to the US Dollar for international transactions for Nigerian traders constituted another issue of concern, as the exchange rate is US \$ 1 = 1,651 Nigerian Naira. These unequal terms of exchange rate were detrimental to imports of gadgets and other AI&T equipment into Nigeria because a prospective farmer who wants to adopt AI&T in his business of agriculture needs to have clearance from the Central Bank and to have other supporting documents in order to open a dollar account for international transaction. This problem was identified as among the major impediments to the implementation of AI&T among Nigerian farmers, and hence, it was responsible for

¹⁰ A, Agwu. "Farmer Literacy Education Strategies for Achieving Poverty and Hunger Reduction among Rural Farmers in Abia State, Nigeria". *Afribary*, Afribary, 21 Apr. 2021. Available at <https://afribary.com/works/farmer-literacy-education-strategies-for-achieving-poverty-and->

[hunger-reduction-among-rural-farmers-in-abia-state-nigeria](#) Accessed on Web. 15 Dec. 2024.

¹¹ 'Concerns and Uncertainty Impede AI Adoption in Companies', in *ETI Report*, 2024,

low produce output and low-profit realization compared with those who adopted the technology in the same trade/economy.

- **Loss of Jobs Due to Automation:** Adopting automation in agriculture using AI&T in Nigeria is becoming a reality. This is due to the population projection that proves that by the year 2050 A.D., the world population is expected to reach 9.8 billion.¹² As the world population grows, food production must increase by at least 50%. According to this analysis, developing countries must double their production by adopting AI&T, intelligent, autonomous machinery for carrying out agricultural tasks essential to improving the quality and quantity of food production.¹³ However, the negative side of the adoption of AI&T on the general public was the loss of means of livelihood (manual labor) to many, as the majority of those engaged in the actual production processes in agriculture were the less privileged who consider their strength as an asset with which to earn a living from working. The resultant effect of adopting AI&T automation in agriculture is that there will be widespread unemployment, poverty, and the spread of social vices, which are all negative trends in any social setting.
- **Lack of Capital Investment in the Implementation of AI&T in Agriculture:** Efforts in this direction have been made at various times throughout Nigeria's agriculture history. For instance, the Green Revolution and Operation Feed the Nation were among the well-pursuit programs of the

state's agriculture department.¹⁴ These programs aim to boost food production capacity and achieve food security. Banks were created in this direction to facilitate easy access to soft loans for farmers through various cooperative societies and farmers' associations. In the theory of operation of the said agencies and institutions, one would become convinced that this was the ideal. However, in reality, massive corruption wrecked the institution to the extent that agricultural banks were seen as pet projects that allowed the political class to appoint their cronies and embezzle the allocated resources to political party supporters. In some instances, private entrepreneurs have started the adoption of AI&T in their farms with support from universities and other agric-based research institutions, but the implementation is still in the embryonic stage.

- **Insecurity of AI&T Gadgets:** As political stability increases, the level of security of life and property follows suit. With current Nigeria's status, security is being threatened by militant groups, insurgents, bandits, Kidnappers,¹⁵ AI&T tools and gadgets cannot be adequately planted on large hectares of land, as some miscreants may see it as an opportunity to remove/steal them without traces. This was so, as wherever the miscreants maintained as their den, not even the state security could reclaim the area talk less of the ordinary citizens.

¹² Department of Economic and Social Affairs, 'World Population Projected to Reach 9.8 billion in 2050, and 11.2 billion in 2100'. UNPF Report, 2024

¹³ Ibid

¹⁴ M. Gavin et. al., *Rural Development in Tropical Africa*, Palgrave: Macmillan (UK), 1981 See also N. Ikenna, The

Green Revolution in Nigeria, or, The Modernization of Hunger, Indiana: Zim Pan Indiana University, 1985

¹⁵ O. O. Oshita et. al., (eds.) *Internal Security Management in Nigeria: Perspective, Challenges and Lessons*, Singapore: Springer Nature Singapore, 2019

Prospects of Incorporating AI&T in Nigeria's Agriculture

The revolution in mathematics and computer science technology has brought unprecedented development in agriculture and other human endeavors. In this section, an attempt will be made to highlight and discuss some of the prospects of incorporation and adoption of AI&T in Nigeria's agricultural production.

First and foremost of the prospects of AI&T in Nigeria's agriculture is the increase in high-yield crop production. So often, the majority of the farmers in Nigeria were scattered around the rural areas, which depend primarily on weather vagrancies to produce. However, whenever there are shortages of rainfall or insects attack the produce, the farmers become disadvantaged as they lack the necessary knowledge on how to tackle such threats, and unfortunately, they may end up having little or less produce. Although attempts have been made in this direction by some Nigerian *agritech startups* leveraging AI&T by providing farmers with access to agricultural knowledge, advise services, and other precision farming tools; in this effort, as record shows, farmers' who adopted such technologies were able to triple their crop production and minimise end of season harvest crops lost.¹⁶

Again, adopting AI&T in agriculture facilitate energy harvesting. With this innovation in AI&T, the devices produced provide a sustainable solution to power machines using renewable energy and sunlight which are environmental friendly. One advantage of energy harvesting technology of the AI&T is that such devices can operate long hours without the need to check for refuelling, and they do not release carbon to

the environment which ensures greener and sustainable environment as well.¹⁷ So, by adopting energy harvesting technology of the AI&T in Nigeria as a nation, this could save her environment from desertification and Sahara encroachment which is most prevalent in the northern region where the agriculture really matters. For according to scientific reports, a total of about 15% of Nigeria's landmass is prone to desertification, with states as Bauchi, Borno, Gombe, Kano, Jigawa, Kebbi, Sokoto and Zamfara – were classified as 'Desertification Frontline States'; with about 50-75% of their total lands affected by desertification and drought.¹⁸

Another benefit of adopting AI&T in agriculture which has been proved is the Smart Agriculture; this enables the farmer to produce better results, thereby, address the issues of food insecurity. Smart Agriculture has been embraced as a better way to ensure proper monitoring and response to any critical issue on time. According to a testimony of some of those who adopted it, they testified that:

By Adopting network of sensor across agricultural fields, IoT enables real time monitoring of various parameters like soil moisture, temperature, and weather conditions. This constant stream of data helps farmers make friendly decisions such as when to irrigate or harvest, thereby optimising agricultural operations. The implementation of IoT in Agriculture also opens up possibilities for remote monitoring and management, which is particularly beneficial for large scale farming operations.¹⁹

¹⁶ V. Wayan, 9 Ways Artificial Intelligence is Improving Nigeria's Agriculture Outcomes with Small Holder Farmers, available at ictworks.org/ai-improving-nigeria-agriculture/ Accessed 12/12/2014

¹⁷ H. Abbah, et. AL., 'Harvesting the Future: AI and IoT in Agriculture', in E35 Web of Conferences, 477, January, 2024

¹⁸ T. O. Ebenezer, Drought, Desertification and the Nigerian Environment: A Review, In Journal of Ecology and the Natural Environment, Vol. 8, No. 8, July 2015, Pp. 196-209

¹⁹ Ibid

So, adopting AI&T in the Desert Frontline states, as mentioned earlier, which accounted for about 60% of the cultivated lands in Nigeria, there is a tendency for abandoned available lands due to desertification to be put to proper utilization, and at the same time save the environment from other hazards and loss of soil fertility; which, in effect, means more food and employment for the teeming Nigerian population.

CONCLUSIONS AND RECOMMENDATION

The development of AI&T and its eventual incorporation in agriculture is undoubtedly a positive step towards improving the sector, considering the changing environment due to human activities and global warming, which caused arable and fertile lands to lose fertility and shortages of rainfall distribution. In this sense, by adopting AI&T, there is the hope that nature would recapture and replenish the earth's resources, which means more land utilization, yields, and end-of-season harvest without harming the environment or nature that sustains it. Moreover, the adoption of AI&T has raised hopes for many farmers to continue the production business as the population increases, which means more profits due to sales and, at the same time, saving money for labor due to automation.

I strongly support the idea that, as a matter of utmost importance, those in the agriculture sector and policymakers in government should develop a mindset shift towards incorporating AI&T. However, it must be made clear that adopting the said revolution and technology in agriculture does not necessarily guarantee positive outcomes; what is important is that all stakeholders, including farmers, must join hands to support the integration of AI&T in the endeavor. With this technology fully integrated and operational in Nigeria's agricultural sector, the issue of food insecurity would vanish, as Nigeria can grow its food to support population increases and at the same time, serve as an impetus towards industrialization and further research in order to

provide job opportunities, and better living conditions for development. Moreover, there is the need to embrace research in seeds improvement based on AI&T to produce genetically modified seeds capable of resisting pests and weather uncertainties, so as to mitigate crop loss.

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