

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

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Abstract

Agriculture has been the mainstay of the Nigeria's majority population as it is self-generating and self-sustaining as well, which continue to provide food and material needs for human sustenance. Over the years, agricultural production continues to provide some opportunities in terms of food production, employment opportunities, and also a source of livelihood. In Nigeria, agriculture continue to face some challenges of which include: 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 in the sector. However, contemporary scientific revolutions in Artificial Intelligence and Technology (AI&T) has 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 in agriculture had addressed some of the challenges facing agricultural sector in Nigeria. Notwithstanding, problems continue to surface in the form of poor technical know of the 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 analyse how the integration of AI&T could be used to harness agricultural potentialities of Nigeria; whereas the data used in this research were mostly secondary sources derived from the academia, United Nations Food & Agricultural Organization (UN/FAO), and other research institutions including universities. For the sake of clarity, questionnaires were administered for data analysis and interpretation.

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

Introduction

Nigeria, a country located on the West African continent, bordered to the north by the Republic of Niger, to the west by Benin Republic, to the east by Cameroon and Chad; whereas to the southern part it bordered by the Bight of Benin and the Atlantic Ocean. This strategic location of Nigeria, had made it suitable for human habitation with a landmass of 923, 000 square kilometres. Different weather and climatic conditions in Nigeria are Sahel Savannah, Sudan Savannah, Guinea Savannah, Tropical rainforest, and swampy areas spread across northernmost parts, the north, central areas, southern region, and the riverine areas respectively. With such vast landmass and different weather and climatic conditions, agriculture had emerged as the dominant economic activity throughout the country for many decades, which provides food, and other needs to support other industries like cloth making, and tannery among others. Over the years, despite the country's available lands and resources, the country continues to fall short of food needs, and other agricultural material needs. These were attributed to weather fluctuations in terms of uneven rainfall distribution, pests and diseases of crops and on animals, loss of soil fertility, and unprecedented population increase which have resulted in rising food imports, and 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 programmes to tackle the issues; some of the programmes 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 programmes 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 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 as presented. Problems as regards to 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

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

(UN/FAO), and the World Food Programme (WFP) just to mention a few. Therefore, as a result of such problems and many more, the programs continue to fail over and over again at different levels to the extent that realization of the objectives of the programmes continue to remain a distant one.

Amidst such crisis of agriculture in Nigeria, there developed artificial intelligence technology; which is the intelligence of a computer machine that enables it to imitate or mimic human capabilities; and this development was embraced by the Nigerians.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, the AI&T is capable to revolutionize agriculture and other businesses based on data analysis and outcome; and lastly, the system uses its assessment to adjust input data, rules and algorithms, and target outcomes.⁶ So, through the use of AI&T, the problems in Nigeria's agriculture could be analysed 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 on data input and proper analysis by AI&T, discoveries determines the outcome of the tasks assigned which were the goals of incorporating AI&T. So, finally, the introduction of this technology had solved many agricultural related problems in Nigeria, albeit some drawbacks.

Conceptual Clarification

Definition of Artificial Intelligence and Technology (AI&T)

There had been a lot of debate about what an Artificial Intelligence technology means. According to Alan Turing, who was considered as the father of AI&T, he defined it as the science and engineering of making intelligent machines, especially intelligent computer programs.⁷ From the above definition, one could conceive that the scholar stated the disciplines

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

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

on which intelligent machines using AI&T could be produced without giving details as to how? Therefore, such view is incomplete and ambiguous to many.

In another definition proposed by Rich Elaine (a computer scientist), he defined it as the study of how to make computers do things that people are better at or would do better at if they could extend what they do to a worldwide web-sized amount of data and not make mistakes.⁸ Elaine's proposition as regards to 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 to those in science and mathematics/logic disciplines. While for other disciplines in humanities and arts, such keywords concepts as used in the definition above need clarification in order to grasp the intended meaning ascribed to them in the definition of AI&T.

On another definition proposed by Kaplan and Heinlein, they defined AI&T as a system's ability to correctly interpret data, and to use those learnings to achieve specific goals and tasks through specific adaptation. This definition sounds flexible indeed, as it provides a vivid and clear guide of what AI&T are set to achieve using the input (data) in respect to a particular tasks assigned.⁹

So, from the above definition attempts, it could be deduced that through incorporation of AI&T in the Nigeria's agriculture - by analysing data as regards to problems, and also using the same AI&T, there would be prospects in addressing the problems which continue to threaten agriculture and humanity at large.

Problems of Incorporating Artificial Intelligence Technology in Nigeria's Agriculture

There are a lot of problems and issues when discussing 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:

- i. **Illiteracy among Farmers:** as it is, the literacy level in Africa and Nigeria in particular is very low when compared to other countries in other continents. So, to persuade farmers in order to understand how the introduction of new technologies and breakthrough in sciences could revolutionize their farming methods and techniques is not easy. Moreover, it requires a lot of resources both human and

⁸ M. Pelicelli . . .Ibid

⁹ M. Pelicelli . . . Ibid.

otherwise to stage public enlightenment campaigns and programmes with a view to achieve a certain level of awareness in order to educate the Nigerian farmers to switch to new farming techniques. Further problem regarding illiteracy among Nigerian farmers was the fact that some machines or concepts produced for agricultural use come with manual; which was a step by step simple guide on how a machine could be assembled, used, and maintained in case of wear, tear, damage or other faults. For instance, advanced tractors, agricultural machines and other equipment in use in modern day agriculture were not like those in the old days. In today's world, all the information required in order to operate any machine is included in its manual, which explains in detail using simplest language and diagrams to acquaint users. The sad part of it as regards to 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, to introduce new machines and modern farming techniques that require the skills of reading for optimal usage is untenable. With majority of the population in Nigeria are farmers living in rural areas, the introduction of basic literacy skills would no doubt enhance production capacity and knowledge based agricultural practices.¹⁰

- ii. Problem of Technical Know How: lack of technical know-how is another impediment to the adoption of AI&T in agricultural production. This is so because; the application of using AI&T in agriculture requires not only the basic knowledge and skills to adopt, but also, a kind of technical expertise and training in computer applications usage in order to get the desired results. Therefore, due to the scanty nature of computer experts in the application of AI&T in agriculture, the sector continues to lag behind. This was among the reasons for low production records and poor data gathering for onward results required to enhance production and monitor decreases or decline in the production due to suspected salient reasons which are hard to notice simply by mere observations on daily basis. 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

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,

- iii. **High Cost of AI&T Adoption:** technology as we have it today, it cost a lot to implement one; especially the computer based technologies which uses AI&T. In Nigeria's case, most of the computer gadgets were produced elsewhere and imported in Nigeria. So, the cost of importation and installation of AI&T gadgets in Nigeria in regards to agriculture in Nigeria is high compared to other countries, where such gadgets had been adopted. Though efforts have been made to produce some of the components locally, but, 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. This unequal terms of exchange rate was detrimental to imports of gadgets and other AI&T equipment into Nigeria, because, a prospective farmer who want to adopt AI&T in his business of agriculture, one 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 the Nigerian farmers, and hence, was responsible for low produce output and low profits realization compared with those who adopted the technology in the same trade/economy.
- iv. **Loss of Jobs Due to Automation:** the adoption of automation in agriculture using AI&T in Nigeria is becoming a reality. This was due to the population projection made that proved by the year 2050 A.D, the world population is expected to reach 9.8 billion.¹² As the world population continue to grow, there is the need to increase food production by at least 50%. In this analysis, developing countries have to double their production by adopting AI&T; which is an intelligent, autonomous machinery for carrying out agricultural tasks essential to improve the quality and quantity of foods production level.¹³ But however, the negative side of adoption of AI&T on the general public was the loss of means of livelihood (manual labour) to many, as majority of those engaged in the actual production processes in agriculture were the less privilege who consider their strength as an asset with which to earn a living from working. And the resultant effect of adoption of AI&T automation in

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

- agriculture means there is going to be widespread unemployment, poverty and spread of social vices as a result; which are all negative trends in any social setting.
- v. Lack of Capital Investment in the Implementation of AI&T in Agriculture: efforts in this direction have been made at various times throughout the history of agriculture in Nigeria. For instance; the Green Revolution and Operation Feed the Nation were among the well pursued programmes of the agriculture department of the state.¹⁴ The aim of these programmes was to boost food production capacity, and hence, to achieve food security. Banks were created in this direction to facilitate easy access to soft loan for farmers through various cooperative societies and farmers' associations. In theory of operation of the said agencies and institutions, one would become convinced that was the ideal. But in reality, massive corruption wrecked the institution to the extent that agricultural banks were seen as pet projects that allow the political class to appoint their cronies and embezzled the allocated resources to political party supporters. At some instances, some 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 at the embryonic stage.
- vi. Insecurity of AI&T Gadgets: as political stability increases, so the level of security of life and property follow suit. With the current Nigeria's status on security which is being threatened by militant groups, insurgents, bandits, and Kidnappers;¹⁵ AI&T tools and gadgets cannot be properly 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.

Prospects of Incorporating AI&T in the Nigeria's Agriculture

The revolution in mathematics and computer science technology had brought unprecedented development not only in agriculture, but also in other human endeavours as well. In this section,

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

an attempt would 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 high yield crops production. So often, the majority of the farmers in Nigeria were scattered around the rural areas, who depend mostly on weather vagrancies to produce. However, whenever there are shortages of rainfall or insects attack on 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

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. &, No. &, July 2015, Pp. 196-209

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

So, adopting AI&T in the Desert Frontline states as mentioned earlier on, which they accounted for about 60% of the cultivated lands in Nigeria, there is the tendency that 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 Nigeria's population.

Conclusions and Recommendation

The development of AI&T and its eventual incorporation in the agriculture is no doubt a positive step towards improving the sector, considering the reality of the changing environment due to human activities and global warming; which made arable and fertile lands to loss their fertility, and shortages of rainfall distribution. In this sense, by adopting AI&T, there is the hope that nature would be recaptured and replenish the earth's resources, which means more lands utilization, more yields and end of season harvest, and without harm to either the environment or nature that sustains it. Moreover, the adoption of AI&T had raised hopes for many farmers to continue the business of production as the population increases, which means more profits due to sales, and at the same time save money for labour due to automation.

I strongly support that as a matter of utmost importance, those in the agriculture sector, and policy makers in government should develop a mind-set shift towards incorporating AI&T. However, it must be made clear that; the adoption of the said revolution and technology in agriculture does not necessarily guaranty positive outcomes in agriculture, what is important is

¹⁹. Ibid

that all stakeholders including farmers must join hands to support the integration of the AI&T in the endeavour. With this technology fully integrated and operational in Nigeria's agricultural sector, the issue of food insecurity would definitely 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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