Utilization of Artificial Intelligence-Enabled Technologies by Agripreneurs in Ondo State, Nigeria

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Abstract

The research investigated the adoption of artificial intelligence (AI) technologies among agricultural entrepreneurs in Ondo state, Nigeria. A purposive sample of 120 participants involved in agriculture was selected for the study. Socioeconomic characteristics analysis revealed that the mean age of the respondents was 48.3 years. A majority (77%) of the respondents were male, and approximately 68% were married. Regarding education, 32.5% had completed secondary education, while 32.5% had tertiary education. The average annual income was 1,166,800 naira, with a significant proportion (71.7%) identifying as Christians. The study found a significant association between respondents' awareness levels and their adoption of AI-enabled technologies (χ^2 = 7.714, p = 0.005). Based on these findings, it is recommended that extension officers receive training in the latest agricultural technologies, including those enabled by AI. Furthermore, the study suggests the introduction of easily accessible and user-friendly AI technologies to farmers to enhance their productivity and income with minimal or no cost implications.

Keywords

Artificial Intelligence, Agripreneurs, Awareness

1. Introduction

Over the years, agriculture has proven to be a steadfast source of income worldwide, satisfying humanity's most essential need: food [1]. However, despite the global need for food, hunger remains an enduring issue, and agriculture, particularly the farming profession, has often been underappreciated compared to other sectors that provide basic human needs. Small-holder farmers have often been marginalized, not always recognized as business owners [2].

Recognizing this gap, the European Commission highlighted the importance of entrepreneurship in agriculture in its sixth research report-framework of 2008, shedding light on the skills required for farmers to thrive in agribusiness. These skills include technical and production skills, business management skills, business opportunity skills, business strategy skills, and networking skills [3]. In particular, technical and production skills are important, as no agricultural venture can succeed without a solid foundation in production.

The combination of technical and production skills with business strategy represents the essence of agricultural entrepreneurship. Furthermore, since the global population is projected to reach approximately 9.5 billion by 2050 [4], the agricultural sector faces the challenge of increasing production while minimising adverse impacts on the environment. This has led to a shift toward more efficient and productive farming methods, often facilitated by Artificial Intelligence [5].

Artificial intelligence (AI), as a powerful tool to improve efficiency and address challenges in various sectors, has profound implications for agriculture [6].

AI's capacity to monitor crops and soil, detect pests and diseases, optimise irrigation, predict weather patterns, enable precision farming, and more positions it as a transformative force in the agricultural landscape [7].

Agripreneurship, on the other hand, represents a concept that combines agriculture and entrepreneurship, with the objective of promoting the development of agribusiness in agriculture and related sectors [8]. It signifies the combination of entrepreneurial innovation and agriculture, with agripreneurs actively engaged in the development, processing, and marketing of new products to add value to the agricultural landscape. However, despite the immense potential AI offers agriculture, the adoption and effective use of these technologies often require a new set of skills and technical expertise. This poses a challenge, particularly since the average age of farmers worldwide falls around 60 years [9]. This is not a good age for technology adoption and innovation, as confirmed in research by [10], stating that younger entrepreneurs do better than those in their third ages (above 50). In addition to this, farmers often struggle with inadequate access to timely, granular weather, pest, and market data, affecting their ability to make informed decisions for crop selection and yield optimisation [11]. To address these issues, AI-powered platforms have emerged, leveraging machine learning algorithms to provide real-time analytics, allowing farmers to manage production risks, optimise resource use, and improve yields and farm-gate prices [12].

The Nigerian Agricultural Sector

Poverty and food scarcity persist as the main challenges in Nigeria, particularly impacting rural communities, where the majority of agricultural activities occur [13]. Although the agricultural sector already contributes significantly to the nation's economy, accounting for approximately 22% of GDP [14] as it remains the

largest employer of labor in the country. There is still a pressing need for increased production to adequately feed the population and increase export, thereby enhancing the economic potential of agricultural entrepreneurs in the nation. [15] identified the inability to meet domestic food requirements and the failure to export products to the required quality levels as the main issues confronting the Nigerian agricultural sector and proposed IoT and data analytics as sustainable means of solving these problems.

However adopting and implementing these technologies could be a challenge especially to small holder farmers [16]. Thus, in this study, the perception and awareness of Ondo State Agripreneurs regarding Artificial Intelligence in agribusiness was assessed by ascertaining the respondents' socioeconomic attributes, assessing their awareness of AI-enabled technologies in agriculture, determining the extent of AI technology adoption among respondents, and assessing their perceptions of AI's impact on the agricultural sector. We also confirmed through analysis that there is a significant relationship between the level of awareness of the respondents about existing technologies enabled by artificial intelligence and their use of these technologies. The contribution of this study to knowledge includes.

• Enhanced understanding of the socioeconomic characteristics of agripreneurs in the ondo state: This study enriches our understanding of the socioeconomic background of agripreneurs in the Ondo state. By unraveling the intricate web of their economic and social characteristics, it paints a more detailed portrait of the agricultural landscape in the region.

• Insight into Ondo State Farmers' Perspectives on AI enabled Technologies: This research sheds light on the extent to which farmers in Ondo State are familiar with artificial intelligence and its potential applications within the realm of agriculture. Defining the level of exposure and awareness of AI bridges the knowledge gap in this crucial domain.

• Awareness and Utility of AI enabled technologies among Ondo State's Farming Community: The study offers valuable information on the awareness of AI by farmers in the Ondo State in their agricultural ventures. This understanding provides a nuanced view of their attitudes and sentiments towards integrating AI technologies into their businesses, enriching the discourse on technology-driven agribusiness transformation.

2. Materials and Methods

This research was carried out in Ondo state, Nigeria, covering an area with coordinates 7˚10'N and 5˚05'E, spanning approximately 15,500 square kilometres. To ensure geographic diversity and representation of agribusiness activities, a systematic random sampling method was used to select six of the 18 local government areas. These areas included Akure-South, Ifedore, Owo, Akure-North, Idanre, and Ondo-West.

Data were collected from 120 actively engaged agribusiness professionals, with

10 respondents purposefully selected from each of the six chosen local government areas, including cash crop and poultry farmers. Data were collected through pre-tested questionnaires. Statistical tools such as tables, figures, percentages, chi-square tests, and product-moment correlation were used for data analysis, to assess relationships and correlations between variables, and to test hypotheses. This research methodology ensures the reliability and validity of the findings, providing a comprehensive understanding of agribusiness, AI awareness, and the adoption of technology among Agripreneurs in the state of Ondo, facilitating meaningful conclusions in the study.

3. Results and Discussion

This highlights the results obtained from the study while briefly discussing the implication of each result.

3.1. Socio-Economic Characteristics of the Respondents.

Table 1 shows that 75% of the respondents are male, indicating male dominance in agriculture, probably due to the physically demanding nature of the occupation. This is consistent with the findings of [17] to determine male dominance in agriculture. This study also reveals that 55.8% of the respondents are 40 - 59 years old, with an average age of 48.3, suggesting a relatively mature population involved in agriculture.

The majority, 66.7% of the respondents, are married, indicating a potential interest in AI-enabled technologies to improve family welfare. In terms of education, 40.8% completed tertiary education and 53% earned between N 500,001 and N 1,000,000 annually, showing financial capacity for AI-enabled tools. This financial ability of the respondents differs from the findings of [18] revealed that the average monthly income of the farmers is less than N 30,000 per month. In terms of religion, 71.7% are Christians, emphasising Christianity's dominant presence in Ondo state, offering a platform for AI technology information dissemination.

3.2. Level of Awareness of the Respondent of Artificial Intelligence

The grand mean level of general awareness of the respondents about artificial intelligence is $\overline{x}$ = 1.96. As presented in Table 2, breaking it down into aware and unaware based on the score that is above or below the grand mean score, the respondents are aware about AI based on questions such as Indicate your level of awareness of AI agriculture ($\overline{x}$ = 2.28), Agripreneurs can use AI on their phone ($\overline{x}$ = 2.18) and AI has not only to do with using robots for work ($\overline{x}$ = 1.97), while there is no awareness of the questions, every farmer can use artificial intelligence tools on their farms ($\overline{x}$ = 1.93), most people who use a smart phone already use artificial intelligence ($\overline{x}$ = 1.93), AI makes machines learn to make decisions like humans ($\overline{x}$ = 1.79), artificial intelligence-based technologies have

helped farmers produce more output with less input ($\bar{x}$ = 1.75) and AI is not just about hardware equipment ($\bar{x}$ = 1.75). This study supports the findings of [19] who revealed awareness of artificial intelligence among poultry farmers. It can be deduced that awareness of the concept of Artificial Intelligence continues to gain ground in the agricultural sector of the country.

Table 1. Respondents Socio-economic Characteristics.

Variables	Frequency	Percentage (%)	Average
Sex			
Female	30	25.0	
Male	90	75.0	
Age (years)			
20 - 39	31	25.8	
40 - 59	67	55.8	48.3
60 - 79	21	17.5	
80 Above	1	0.8	
Marital status			
Single	28	23.3	
Married	80	66.7	
Divorced	4	3.3	
Separated	4	3.3	
Widowed	4	3.3	
Educational level			
No formal education	9	7.5	
Primary	16	13.3	
Secondary	39	32.5	12.3
Tertiary	49	40.8	
Post-graduate	7	5.8	
Annual Income (Naira)			
below 100,000	2	1.7	1,166,800
10,000	29	24.2	
500,001 - 1,000,000	63	52.5	
1,000,001 - 1,500,000	10	8.3	
1,500,001 - 200,000	0	0	
2,000,001 and above	16	13.3	
Religion			
Christian	86	71.7	
Islam	25	20.8	
Traditional	9	7.5	

Source: Field Research (2021).

Table 2. Level of awareness of artificial intelligence among respondents.

Awareness Statement	Not at all aware	Slightly aware	Somewhat aware	Moderately Aware	Extremely aware	Mean	Awareness
Indicate your level of awareness of AI in agriculture.	17 (14.2%)	28 (23.3%)	33 (27.5%)	25 (20.8%)	17 (14.2%)	2.28	Aware
Agripreneurs can use Artificial Intelligence enabled technologies on their mobile phones.	13 (10.8%)	21 (17.5%)	38 (31.7%)	27 (22.5%)	21 (17.5%)	2.18	Aware
AI has to do with not only using robots for farm work.	33 (27.5%)	23 (19.2%)	22 (18.3%)	26 (21.7%)	16 (13.3%)	1.97	Aware
Every farmer can use artificial intelligence tools on their farms.	17 (14.2%)	28 (23.3%)	33 (27.5%)	25 (20.8%)	17 (14.2%)	1.93	Unaware
Most people who use a smart phone already use artificial intelligence.	21 (17.5%)	13 (10.8%)	35 (29.2%)	35 (29.2%)	16 (13.3%)	1.93	Unaware
Agripreneurs may not necessarily have technical knowledge before using it.	23 (19.2%)	20 (16.7)	35 (29.2%)	26 (21.7%)	16 (13.3%)	1.79	Unaware
Artificial intelligence-based technologies have helped farmers produce more output with fewer inputs.	14 (11.7%)	22 (18.3%)	20 (16.7%)	44 (36.7%)	20 (16.7%)	1.75	Unaware
Artificial intelligence is not just about hardware equipment.	26 (21.7%)	22 (18.3%0	36 (30.0%)	28 (23.3%)	8 (6.7%)	1.75	Unaware

Source: Field Research (2021).

3.3. Number of Respondents Using Artificial Intelligence-Enabled Technology

The result of Table 3 below shows that 77.5% of the respondents are using artificial intelligence-enabled technologies, while the remaining 22.5% do not use artificial intelligence-enabled technology at all. Of the 10 common technologies listed, only 3 are currently being used by respondents who indicated yes for usage. These 3 are:

• Weather Forecast: 43 of the 93 respondents state that they use the weather forecast application on their phones to predict and confirm activities for the coming days, weeks, and months.

• Land mapping and survey: 57 respondents have used land mapping and survey tools on their farm. Although most (70.18%) of them used phone applications for this, the remaining have contracted this out to an organisation that uses unmanned aerial vehicles and other mapping software.

• Record Keeping and Stock Keeping: Only eight respondents have used this technology, and they were among the respondents who used outsourced land survey and mapping. 6 of them had got a digital count of trees on their farms, thus predicting the amount of input they would use and expected output for the year.

This implies that although artificial intelligence enable technology may be alien to many small-holder farmers, it is fast spreading among in the agriculture industry, and this could be due to its usefulness to the farmers.

3.4. Perceived Benefits of AI in Agriculture

The grand mean score for the perceived benefits of AI in agriculture is $\overline{x}$ = 2.64. Benefits such as AI help to collect good and consistent data ($\overline{x}$ = 2.90), AI has helped agripreneurs in good records ($\overline{x}$ = 2.81), it can help to select hybrid seed choice for soil and climate ($\overline{x}$ = 2.72), AI makes precision agriculture possible ($\overline{x}$ = 2.70) and the use of AI has helped many farmers access more credit for their production ($\overline{x}$ = 2.67) is perceived as a benefit of AI for agriculture as shown in Table 4, while AI has helped increase agricultural input with less labour ($\overline{x}$ = 2.57), various AI tools have helped in weeding, irrigation, early harvesting ($\overline{x}$ = 2.53) and AI can help forest fire detection ($\overline{x}$ = 2.23) not perceived as benefits of AI for agriculture. In general, the respondents perceive AI to be beneficial and beneficial to agriculture. This study supports [20], who confirmed the benefits of AI in agriculture.

3.5. Hypothesis Testing: There Is No Significant Association between the Level of Awareness of the Respondents and the Use of Technologies Enabled by Artificial Intelligence

Chi-square was used to test the association between the level of awareness of the respondents and their use of technologies enabled by artificial intelligence. Table 5

Table 3. Distribution of respondents using technology enabled by artificial intelligence.

Usage to AI-enabled technologies	Frequency	Percentage (%)
Yes.	93	77.5
No	27	22.5
Total	6	100

Source: Field Research (2021).

Table 4. Perceived Benefits of AI in Agriculture.

Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Mean	SD
1. AI helps to collect good and consistent data.	0 (0.0%)	4 (3.3%)	36 (30.0%)	48 (40.0%)	32 (26.7%)	2.90	0.83
2. AI has helped Agripreneurs in good record keeping.	3 (2.5%)	2 (1.7%)	35 (29.2%)	55 (45.8%)	25 (20.8%)	2.81	0.87
3. It can help select the hybrid seed choice that is best suited for soil and climate.	1 (0.8%)	4 (3.3%)	40 (33.3%)	57 (47.5%)	18 (15.0%)	2.72	0.78
4. AI makes precision agriculture possible	4 (3.3%)	4 (3.3%)	45 (37.5%)	39 (32.5%)	28 (23.3%)	2.70	0.98
5. The use of artificial intelligence (AI) has helped many farmers access more credit for their production.	1 (0.8%)	4 (3.3%)	49 (40.8%)	46 (38.3%)	20 (16.7%)	2.67	0.82
6. AI has helped to increase agricultural input with less labour.	4 (3.3%)	17 (14.2%)	30 (25.0%)	45 (37.5%)	24 (20.0%)	2.57	1.07
7. Various AI tools have helped with weeding, irrigation, early harvesting, etc.	7 (5.8%)	7 (5.8%)	37 (30.8%)	53 (44.2%)	16 (13.3%)	2.53	0.99
8. AI can help forest fire detection.	6 (5.0%)	11 (9.2%)	61 (50.8%)	34 (28.3%)	8 (6.7%)	2.23	0.89

Source: Field Research (2021).

Table 5. Association between level of awareness of respondents and use of technologies enabled by AI.

Variable	Usage of artificial intelligence enabled technologies			
	x^2	df	p-value	D
Level of awareness	7.714	1	0.005	S

*Significance at ≤0.05. Source: Filed Study (2021).

reveals that the level of awareness (x^2 = 7.714, p = 0.005) among respondents in the study area is significantly related to their use of artificial intelligence-enabled technologies. Awareness is a state where one knows about the existence of something. This implies that the respondent's awareness of artificial technologies is the spark for their use of them.

4. Conclusion

Based on the findings of this study, it can be concluded from the results of this study that the majority of farmers who know about and use artificial intelligence enabled technologies are those who are connected in some way or another to the organizations that provide the services to them. Respondents who were randomly selected were unaware of the use of technologies enabled by artificial intelligence. From additional research and investigation, it was found that none of these respondents who knew or used artificial intelligence-enabled technologies received their information from an agricultural extension agent. This poses a major source of concern for the public agricultural extension system. This study therefore recommends that the Nigerian government invest more in growing the agricultural sector by educating farmers on the use of Artificial intelligence enabled Technologies for increased production.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Bhati, P., *et al.* (2024) Integrated Farming Systems for Environment Sustainability: A Comprehensive Review. *Journal of Scientific Research and Reports*, **30**, 143-155. https://doi.org/10.9734/jsrr/2024/v30i11834

[2] FAO (2017) The Future of Food and Agriculture—Trends and Challenges. Annual Report, Vol. 296.

[3] Deekor, H. (2019) The Role of Agricultural Entrepreneurship Education in Employment Generation and Community Empowerment. No. March, 2-8.

[4] Kakani, V., Nguyen, V.H., Kumar, B.P., Kim, H. and Pasupuleti, V.R. (2020) A Critical Review on Computer Vision and Artificial Intelligence in Food Industry. *Journal of Agriculture and Food Research*, **2**, Article ID: 100033.
https://doi.org/10.1016/j.jafr.2020.100033

[5] Talaviya, T., Shah, D., Patel, N., Yagnik, H. and Shah, M. (2020) Implementation of Artificial Intelligence in Agriculture for Optimisation of Irrigation and Application of Pesticides and Herbicides. *Artificial Intelligence in Agriculture*, **4**, 58-73.
https://doi.org/10.1016/j.aiia.2020.04.002

[6] Krafft, P.M., Young, M., Katell, M., Huang, K. and Bugingo, G. (2020) Defining AI in Policy versus Practice. *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*, New York, 7-8 February 2020, 72-78.
https://doi.org/10.1145/3375627.3375835

[7] Sharma, R. (2021) Artificial Intelligence in Agriculture: A Review. 2021 5*th International Conference on Intelligent Computing and Control Systems* (*ICICCS*), Madurai, 6-8 May 2021, 937-942. https://doi.org/10.1109/ICICCS51141.2021.9432187

[8] Lal Bairwa, S., *et al.* (2014) Agripreneurship Development as a Tool to Upliftment of Agriculture. *International Journal of Scientific and Research Publications*, **4**, 1-4.
https://www.ijsrp.org

[9] Carnegie, M., Cornish, P.S., Htwe, K.K. and Htwe, N.N. (2020) Gender, Decision-Making and Farm Practice Change: An Action Learning Intervention in Myanmar. *Journal of Rural Studies*, **78**, 503-515. https://doi.org/10.1016/j.jrurstud.2020.01.002

[10] Colovic, A., Lamotte, O. and Bayon, M.C. (2019) Technology Adoption and Product Innovation by Third-Age Entrepreneurs: Evidence from GEM Data. In: Maâlaoui, A., Ed., *Handbook of Research on Elderly Entrepreneurship*, Springer International Publishing, Berlin, 111-124. https://doi.org/10.1007/978-3-030-13334-4_7

[11] Cook, P. and O'Neill, F. (2020) Artificial Intelligence in Agribusiness Is Growing in Emerging Markets. https://doi.org/10.1596/34304

[12] Csillik, O., Cherbini, J., Johnson, R., Lyons, A. and Kelly, M. (2018) Identification of Citrus Trees from Unmanned Aerial Vehicle Imagery Using Convolutional Neural Networks. *Drones*, **2**, Article No. 39. https://doi.org/10.3390/drones2040039

[13] Omodero, C.O. (2021) Sustainable Agriculture, Food Production and Poverty Lessening in Nigeria. *Transport*, **3**, 6.

[14] Oyaniran, T. (2020) Current State of Nigeria Agriculture and Agribusiness Sector. AfCFTA Workshop.
https://www.pwc.com/ng/en/assets/pdf/afcfta-agribusiness-current-state-nigeria-agriculture-sector.pdf

[15] Elijah, O., Orikumhi, I., Rahman, T.A., Babale, S.A. and Orakwue, S.I. (2017) Enabling Smart Agriculture in Nigeria: Application of IoT and Data Analytics. 2017 *IEEE* 3*rd International Conference on Electro-Technology for National Development* (*NIGERCON*), Owerri, 7-10 November 2017, 762-766.
https://doi.org/10.1109/NIGERCON.2017.8281944

[16] Kaliyaperumal, K., Mahalakshmi, V., Selvam, P.M.S., Priya, T., Narayana, B.L. and Pradeep, T. (2023) Challenges and Prospects of Implementing Information and Communication Technology for Small-Scale Farmers. In: Krishnan, S., *et al.*, Eds., *Predictive Analytics in Smart Agriculture*, CRC Press, Boca Raton, 1-19.
https://www.taylorfrancis.com/chapters/edit/10.1201/9781003391302-9/challenges-pr

ospects-implementing-information-communication-technology-small-scale-farmers-karthikeyan-kaliyaperumal-mahalakshmi-sithar-selvam-priya-lakshmi-narayana-pradyan-kaliyaperumal-mahalakshmi-sithar-selvam-priya-lakshmi-narayana-pradeep

[17] Wole-Alo, F.I. and Oluwagbemi, I.O. (2020) Adoption and Utilization of ICT through Farmers.NG Technology in Ondo State, Nigeria. *International Journal of Applied Agricultural Sciences*, **6**, 7-15. http://www.sciencepublishinggroup.com

[18] Oni, O.O., *et al.* (2022) Socioeconomic Characteristics of Farmers, Profitability and Militating Factors Affecting Small Ruminant Production in Ondo State, South-West, Nigeria. *International Journal of Environment, Agriculture and Biotechnology*, **7**, 69-77. https://doi.org/10.22161/ijeab.72.7

[19] Adetomiwa, K. (2020) Adoption and Utilization of Artificial Intelligence (AI) in Poultry Production: Evidence from Smart Agricultural Practices in Nigeria. *International Journal of Agriculture and Environmental Science*, **7**, 46-54. https://doi.org/10.14445/23942568/IJAES-V7I3P106

[20] Longinus, O. (2018) Artificial Intelligence System: Implication for Proper Record Keeping in Microfinance Banks in Nigeria. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, **8**, 131-136. https://doi.org/10.6007/IJARAFMS/v8-i1/3926