

OPPORTUNITIES AND CHALLENGES ASSOCIATED WITH AI-BASED DIGITAL TECHNOLOGIES USAGE FOR AGRICULTURAL EXTENSION SERVICES IN NIGERIA

Olanike Fasilat DEJI¹, Michael FAMAKINWA¹, Ebunoluwa Oyindamola FANIYI²,
Toyin Femi OJO¹, Aanuoluwapo Oladipupo OPAYINKA¹

¹Obafemi Awolowo University, Department of Agricultural Extension & Rural Development, Ile-Ife, Nigeria. E-mail: odeji@oauife.edu.ng, mfamakinwa@oauife.edu.ng, tfojo@oauife.edu.ng, aopayinka@gmail.com

²Rufus Giwa Polytechnic, Department of Agricultural Extension and Management, Owo, Nigeria. E-mail: ebunfaniyi@gmail.com

Corresponding author: mfamakinwa@oauife.edu.ng

Abstract

Digitalization of agriculture has been identified as panacea to the problem of food security to teeming population, although its uses for agricultural extension services is still evolving and challenging among extension professionals. This study examined the opportunities and challenges of using AI-based digital tools for agricultural extension services in Nigeria; the study described the socioeconomic characteristics of extension professionals and identified the effects of its usage on extension service delivery. An online questionnaire was used to gather primary data from 131 agricultural extension professionals drawn across the states in Nigeria. Frequency counts, percentages and means were used to analyse and summarize the data collected. The result reveals that majority (75.6%) were male with a mean age of 48.1±15.8 years. The respondents mostly identified provision for real-time insights into the farms and landscape (97.7%) and provision of reliable farm data (75.6%) as the major opportunities for AI-based Digital tools for agricultural extension service, while lengthy technology adoption Process (94.7%) and higher technical skills (70.2%) were the major challenges identified with the use of AI-based digital tools for agricultural extension services by the respondents. The study also reveals that respondents mostly indicated timely enhancement of communication (88.5%) and provision of an update on best practices globally (64.1%) as the key effects of AI-based digital for agricultural extension services. The study recommends that capacity building of extension professionals and farmers; involvement of farmers and other agriculture value chain stakeholders in the development of digital technologies; as well as provision of digital infrastructures and enablers which are germane for digitalization and utilisation of AI-based digital tools for agricultural extension service delivery in Nigeria.

Key words: agricultural extension delivery, extension professional, digital tools, information dissemination, utilisation

INTRODUCTION

Dissemination of agricultural information is a crucial task performed by agricultural extension to link agricultural stakeholders with the most recent technology required for optimal performance that would lead to the growth of the community at large [1]. According to [21], the availability of quality information and its frequent flow to the farming community has a direct relationship with better farm production and the prosperous life of the clientele. Agricultural extension and advisory services (EAS) make it easier for farmers to access the information, knowledge, tools, resources, and financial services needed to increase their productivity

and subsequently, their farm and non-farm earnings especially in challenging and emergencies as witnessed during emergence of Covid-19 pandemic which negatively impacted on every sector of the society all over the world [4]. But many rural regions of the world still have serious issues with access to agricultural extension services. The lockdown and its attendant restrictions from nations' government prevent close contact between people, as evident in agricultural extension services which largely requires face-to-face interaction with smallholder farmers for farm visits, training, demonstrations, exhibitions, and field days. This automatically led to a reduction in

farmers' access to appropriate extension services. This necessitates the adoption of alternative ways of transferring innovations and improved technologies to smallholder farmers. Apart from this, Covid-19 has indeed presented an opportunity for extension professionals to be creative and think of alternative ways of reaching out to farmers in the era of Information Communication Technology and globalized community [10]. AI-based technologies on digital platforms have become an alternative response for agricultural extension and advisory services to farmers in post-Covid -19 era [4].

Artificial intelligence (AI) is becoming more prevalent worldwide in recent times. It is a creative tool that mimics how human intelligence and technology work, particularly computer systems, robots, and digital devices [3]. [8] defines AI as the emulation of human intelligence (thus, artificial) into machines for tasks that would typically need humans. Complex algorithms and mechanical processes are used to create this intelligence. They are used in smartphones, cars, social media fields, surveillance, and many more. Artificial intelligence is playing a vital role in modernizing agricultural extension activities. Artificial intelligence systems for extension work will require the constant provision of new information and increasing the amount of information in the back-end database used to perform tasks with greater accuracy.

[23] observed that AI is advancing rapidly and is widely accepted. According to their studies, AI technologies inevitably have the potential to empower people and communities, resulting in more significant social change and better quality of life. [9] reported that several AI-based digital technologies have been deployed and used for agricultural extension and advisory services by smallholder farmers in many African countries. These digital technologies include Esoko, Agrohub, M-Farm, Kilimo Salama, M-Shamba, iCow, MyAgro, Senekela, WeFarm, Farmdrive, mAgri and among others. The benefits of AI-based digital agricultural extension and advisory services are inestimable, especially in the context of the global emergent information economy.

[7] observed that AI-based tools have the potentials of digitalizing agriculture systems and taking it to a higher level in data gathering, dissemination, and advisory services, as well as production and consumption. [20] discovered that AI-based technologies have brought about tremendous increase in productivity in all industries and agricultural sector. In the area of agriculture, AI-based tools have provided solutions the problems of crop yield, irrigation, soil content sensing, crop monitoring, weeding, pest and disease control, crop management, harvesting, processing value addition and marketing.

According to [19], digital technologies could assist in many ways to better tailor various agricultural advisory services to farmers' needs. For instance, location-specific agricultural advice such as weather forecasts, soil conditions, market prices, and other aspects can be developed and delivered to individual farmers through predictive analytics and machine learning algorithms. From the foregoing, the potential of AI-based digital agricultural extension and its attendant challenges is yet to be adequately documented. Identifying challenges seems to be crucial, if those working on a system are not aware of its potential problems, those problems can become threats; with more knowledge, however, they can become opportunities. Unfortunately, insufficient empirical evidence on the opportunities and challenges of AI-based digital agricultural extension and advisory services in Nigeria. Hence this study examined the opportunities and challenges associated with the use of AI-based digital technologies for agricultural extension services in Nigeria. The study profiled the socio-economic characteristics of the respondents in the study area; highlighted opportunities of using AI-based digital technologies for agricultural extension services; highlighted challenges of using AI-based digital tools; and identified the effects of using AI-based digital technologies for agricultural extension service delivery.

Theoretical Framework

This theoretical background for this study is based on the “Use and Gratification” theory of communication propounded by Jay Blumler and Elihu Katz in 1974 which examined media consumption and what benefits it creates for the consumer [5]. The theory explains why people choose and use certain media forms and emphasizes that media have a limit or limited effect on their audience because the audience is able to exercise control over their media. The fundamental idea is that audiences turn to media because they expect media to gratify specific needs. Use and Gratification theory was posited to investigate how media is consumed, and the possible effects the media has on society at large. The emergence of AI digital agricultural extension services has a lot of benefits that will necessitate extension professionals and farmers to adopt these technologies to boost agricultural production and overcome the problems of face-to-face traditional extension approaches

In this context, the aim of the study is to identify the opportunities and challenges of using AI-based digital tools for agricultural extension services in Nigeria.

MATERIALS AND METHODS

Sampling techniques

The study was carried out in Nigeria. The population for the study were extension professionals who were members of various extension professional associations such as RuSAN, AESON and CYIAP. Questionnaire was prepared and validated among experts from the Agricultural Extension and Computer Science departments using an online Google form to obtain a standardized questionnaire. An online validated questionnaire with open and closed questions was administered to 282 extension professionals through their individual e-mail addresses obtained from their professional associations. While a total of ninety-two non-registered extension professionals including contact farmers (farmer-led extension workers) and lecturers in the department of agricultural extension in various institutions in Nigeria were individually contacted. After six

weeks, a total of 131 online questionnaires were completed and submitted by these extension professionals. Data collected were processed through Excel sheet and IBM SPSS version 23 and data were analysed through the use of appropriate descriptive statistical tools to summarise the data.

Measurement of variables

Perceived opportunities were measured by asking the respondents to respond to each of the listed conventional opportunities associated with the use of AI-based digital tools for agricultural extension. Yes, was scored one point while no was scored zero. to each listed conventional extension activity. The Maximum score was nine while the minimum was 0. Challenges to the use of digital tools was determined by requesting the respondents to respond to the listed challenges. Positive response was scored one point while no was scored zero. The Maximum score was nine while the minimum was 0. The effects of using AI-based digital technologies for agricultural extension and advisory services was achieved by requesting the respondents to the listed effects of AI-based digital tools for extension service delivery. Their responses were scored as one point for positive response while zero point as negative response.

RESULTS AND DISCUSSIONS

Socio-economic characteristics

Table 1 shows that the mean age of extension professionals was 47.6 ± 15.8 years. This suggests that majority of the extension professionals are in their active age, this could have positive implication on the utilization of AI-based technologies because younger people are more adventurous, willing to explore Hi-Tech devices. Also, majority (75.6%) of the respondents were males. this reveals male dominance in extension profession composition in Nigeria. This finding corroborates with the submissions of [2], [17] and [18] that reported male's domination in extension service in South-Western Nigeria. This signifies that the females are less represented in the agricultural extension and advisory system in Nigeria,

which may negatively influence female farmers' access to information and technologies. Majority (89.3%) of the respondents had at least B.Sc. degree. This means that the respondents in the study area were highly educated and had necessary academic qualification which might be needed to adopt AI-based digital technologies for effective extension service delivery. Also, 30.5% and 29.8% were lecturers and researchers in agricultural extension profession. The result shows that every stratum of extension professionals were included to give their opinions on the use of these emerging technologies in agricultural extension services.

Table 1. Respondents' socio-economic characteristics

Variables	Frequency	Percentage	Mean ± St. Dev.
Age			
> 30	12	9.2	
31-45	35	26.7	48.1±15.8
46-60	67	51.1	
≤ 61	17	13.0	
Sex			
Male	99	75.6	
Female	32	24.4	
Level of Education			
ND	3	2.3	
HND	11	8.4	
B.Sc.	39	29.8	
M.Sc.	51	38.9	
Ph.D.	27	20.6	
Categories of extension professional			
Extension Lecturers	40	30.5	
Extension Researchers	39	29.8	
Public Extension Agents	32	24.4	
Private Extension Agents	11	8.4	
Farmer-led extension workers	9	6.9	

Source: Online survey, 2021.

Opportunities for AI-based digital technologies for agricultural extension services

Table 2 reveals that the majority (97.7%) of the extension professionals indicated that AI-based technologies used for extension services offer an opportunity of providing real-time insights. This is because these technologies have the ability to create awareness, assist during sessions of emergency operations, disseminate accurate and real-time information to rural farmers, and teach them to utilize good agronomic practices [11]. The

majority (75.6%) of the respondents indicates that the provision of reliable farm data was an opportunity for using AI-based Digital technologies for Agricultural Extension and Advisory Services in Nigeria.

About 67.2% perceived that AI-based digital technologies also help in the proper identification and treatment of farm diseases.

This is due to the simplicity with which farmers can obtain information on how to identify and diagnose pests and diseases, as well as how to differentiate diseases with similar symptoms, how to use biological pest and disease control methods, and the appropriate stage at which to control pests and diseases.

This agrees with the results of [12] who submitted that smallholder farmers in Uganda and Kenya acquired information on the identification and treatment of diseases from digital extension and advisory services. It is also consistent with the submissions of [22] and [16] that management of crop and animal diseases can be done through the use of digital technologies.

About 57% of extension professionals also indicated that AI-based digital technologies are effective in farm management.

This is because it is very easy to get information on weather forecasting, market information, good agronomic practices, credit facilities, quality seeds, fertilizer use, and water management which are essential ingredients of effective farm management.

Besides, half (53.3%) of the respondents perceived AI-based digital technologies for agricultural extension and advisory service offers the opportunity of providing effective communication and advisory services even during times of emergency.

This is because AI-based digital technologies is an interactive platform that has the capacity of providing effective interaction between extension agents and farmer beyond the traditional face-to-face approach, through which information on improved agricultural technologies can be disseminated to the farmers without any delay.

Table 2. Opportunities of using AI-based digital technologies for agricultural extension Services

**Opportunities	Frequency	%
Provision of real-time insights	128	97.7
Reliable farm data	99	75.6
Reliable problem identification and treatment	88	67.2
Effective farm management	75	57.3
Effective communication and advisory services	70	53.4
Improved trust between farmers and extension agents	56	42.7
Increased production	38	29.0
Improved farmers and household livelihood	31	24.0
Reduced vulnerability	22	17.6

**Multiple responses.

Source: Online survey, 2021.

Challenges associated with the used of AI-based digital technologies

The evidence in Table 3 show that the majority (94.7%) of the respondents indicated a lengthy technology adoption process as the prime challenge of using AI-based digital technologies for agricultural extension and advisory services. This supports the submission of [10] who identified the lengthy technology adoption process as one of the constraints of using AI digital tools in extension services. This is because [6] described AI-based digital technologies as a more advanced version of basic technologies for processing, acquiring, and monitoring field data. This requires a proper technological infrastructure and internet connectivity, which are not readily available at present in rural communities as reported by [24]. As a result of this, it will take a longer time for extension professionals and farmers to tap this opportunity in using these tools for agricultural extension and advisory services. The majority (70.2%) of the respondents reveal that lack of higher technical skills was also a challenge to the use of AI-based digital technologies for agricultural extension and advisory services in Nigeria. The prerequisites for using and accessing various digital resources and services are digital literacy and skills which many of the extension personnel and farmers do not possess for the utilization of this AI-based digital technology. This buttress the finding of [15] that most farmers lacked digital skills in using mobile digital applications to access agricultural information.

The majority (65.5%) of the extension professionals also identified privacy and security threat as one of the perceived threats to the use of AI-based technologies. Owing to no clear-cut policies and regulations regarding the use of AI in cyberspace and particularly in agriculture in Nigeria, Extension professionals and farmers may likely face major challenges of privacy and security threats like cyber-attacks and data leaks which could give access to some unwanted people or entities to hack their data [14].

Inadequate involvement of farmers, and other stakeholders' capacity building in the technology development (60.3%) was also identified by the extension professionals as one of the challenges of using AI-based digital technologies for agricultural extension and advisory services. Inadequate involvement of farmers, extension professionals, and other stakeholders in the development of AI-based digital tools for agricultural extension and advisory services could pose a great challenge for them in using these AI-based digital tools effectively for agricultural extension and advisory services. This is because a clear understanding of the audience and their technological aptitude is critical to the positive experience of the users. This supports the position of [9] who submitted that success of AI-based technologies in agricultural extension services is a fundamental thorough understanding of the needs, dynamics, and challenges of the users.

Table 3. Challenges to the use of AI-based Digital technologies

**Challenges	Frequency	%
Lengthy technology adoption process	124	94.7
Requires higher technical skills	92	70.2
Privacy and security threats	86	65.6
Inadequate involvement of farmers and other stakeholders in capacity building and technology development	79	60.3
High-cost implication	64	48.9
Big data management for informed decision –making	28	21.4
Management of internet of Things	22	16.8
Inadequate interdisciplinary AI research and communication	16	12.2

**Multiple Responses.

Source: Online survey, 2021.

Effects of using AI-based digital technologies for agricultural extension services

The results in Table 4 reveals that extension professionals mostly identified timely enhancement of communication (88.5%), providing an update on best practices globally (64.1%), and improved the quality of extension services (51.1%) as the perceived effects of AI-based digital technologies for agricultural extension and advisory service delivery in Nigeria. This is because AI-based technology allows for flexible communication with people regardless of their locations or time of the day and provides capacity for data acquisition and storage. AI-based digital technologies for agricultural extension and advisory services also provide timely and accurate farm data on agricultural information to clientele and extension professionals in all aspects of agriculture which can improve agricultural production. It is evident in these results that extension experts' perception about the use of AI-based digital technologies for agricultural extension and advisory services was similar to that of [13] that stated that extension experts perceived that AI-based technologies for agricultural extension and advisory services had positive effects on the quality of the content and services they delivered. As a result of this, AI-based digital tools for agricultural extension and advisory services could enhance the provision of need-based services to the farmers and other agriculture value chain actors in the agricultural production system

Table 4. Effect of the AI-based Agricultural Extension and Advisory Services

**Effects	Frequency	%
Enhance timely communication	116	88.5
Update on best practices globally	84	64.1
Improves quality services	67	51.1
Help professionals to compete favourably at global platform	57	43.5
Loss of job for extension professionals	56	42.7
Enhance interdisciplinary and holistic expertise	56	42.7
Enhance adequate knowledge and skills	54	41.
Results in effective capacity building	51	38.9
Improves job satisfaction	37	28.2

**Multiple Responses.

Source: Online survey, 2021.

CONCLUSIONS

AI-based digital technologies offer great potentials of transforming agricultural extension services in Nigeria by providing an interactive platform for extension agents and farmers' interaction beyond the traditional face-to-face approach. However, some of the challenges identified can limit these opportunities if they are not addressed. Capacity building of farmers, extension professionals and other agriculture value chain actors should be enhanced through regular trainings, seminars and workshops. There is need for the involvement of all relevant stakeholders in the development of digital technologies meant for their use in order to take into consideration their socio-economic characteristics, digital skills, and language before developing such AI tools. There should be a review of the national curriculum for higher institutions to integrate AI technology concepts and practices into extension education. Finally, affordable smartphones, digital infrastructure, good internet facilities, and affordable cost of internet data should be provided by relevant stakeholders and the government to encourage AI-based digital tool usage for agricultural extension services to enhance effective extension service delivery for sustainable agricultural production in in Nigeria.

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