FARMERS' PERCEPTION AND WILLINGNESS TO ADOPT DRONE TECHNOLOGY IN AGRICULTURE IN NIGERIA
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ABSTRACT

The application of drones, Unmanned Aerial Vehicles (UAVs), in agriculture has led to a paradigm shift in farming practices by reducing production costs and increasing operational efficiency and profitability. However, there is a paucity of empirical reports on the efficiency and profitability of UAV application to agriculture in Nigeria, limiting the contribution of Nigerian agriculture to the global scientific discourse on drone technology and advancement. This study investigates farmers' perception and willingness to adopt drone technology in agriculture in Nigeria. We employed a physical and online survey method to collect data from 96 respondents spanning 20 States across Nigeria. Data collected was analyzed using descriptive statistics and Binomial logistic regression. Results showed that 82.29% of the respondents were male, and more than 90% completed secondary school education. The average farming experience of households was 2.62 years, and the major crops grown were cassava, maize, and vegetables. All surveyed farmers have a mobile phone, with 98% using the internet and 43.62% producing on a small scale. The major income-generating activities of households included farming, trading, and agricultural processing in order of preference. The farmers' preferred mode of pesticide application was in the order of knapsack (manual) > motorized sprayer > tractor-mounted boom sprayer. 95% of respondents have heard about drones, and their major sources of awareness include social media (61.36%) and websites (19.32%). More than half of the respondents (51.06%) had witnessed a drone demonstration, 22.58% had operated a drone, and 38.3% of the respondent had sometimes employed the service of drone service providers. 98% and 94% of the surveyed farmers opine that drone technology can help overcome farming challenges and enhance agricultural productivity. Moreover, 92.7% of the respondents are willing to pay for the deployment of drone service on their farms, and those willing to engage in its long-term usage are relatively high (96.81%). Farmers prefer applying agrochemicals using drones (66.67%) over the conventional method (33%), with a bias for public-subsidized (22.83%), cooperative or cluster farming engagement (20.65%), and farmer pay (15.22%) drone service delivery model. More importantly, farmers' age and sexual orientation affect their willingness to accept drone technology in agriculture. Finally, we recommend the need for relevant policies to promote drone technology adoption in Nigerian agriculture as a pathway to enhancing efficient and low-cost sustainable food production. Farmers can achieve this by employing the services of drone service providers.

Keywords: agriculture, drones, technology, farmers, precision agriculture, Nigeria

INTRODUCTION

Increased agricultural production has the potential to unlock African prosperity and end hunger and poverty on the continent (African Development Bank, 2021). A vast majority of the African population is engaged in agriculture, contributing up to 60% to the GDP of many African countries through domestic and foreign trade of farm produce (The World Bank, 2021).

The merit of an improved agricultural livelihood system is a better living standard for Africans with increased income, food availability and access, and revenue for effective governance. However, crop and livestock productivity in Africa, especially Nigeria, is lower than global average. (FAO, 2022; Gidanmana, 2020). Increased production has only been seen with increased land cultivation, stocking more animals than effectively managing resources for optimum yield (Jayne & Sanchez, 2021). The consequences include inappropriate fertilizer application, wastage of irrigation water, and pests and weeds infestation, which deprives crops and animals of necessary nutrients and well-being to thrive and be productive. Hence, reduced yield and income become apparent. In the developed world, mechanized farming has been increasingly adopted for improved agricultural efficiency. For instance, the Unmanned Aerial Vehicle (UAV) has been widely employed for spray application of agrochemicals on farms. It helps to map the soil, plants, and animals effectively. It has also been used for fruit picking to prevent on-farm wastage, detecting, and monitoring pest and weed incidence and population, and inaccurate pesticide application for pest eradication. Drones are cost-effective technology for fertilizer delivery and animal feeding to enhance crop and animal growth and development (Doddamni et al, 2020; Kalmkar et al, 2020). UAVs gather data on biotic and abiotic factors for actionable insights on farm planning, production, allocating resources, and yield estimation or prediction that empower farmers with insight that prepares them to make better market decisions (Sylvester, 2018). In Africa and Nigeria especially, the adoption of mechanized technology is low. For instance, there are just 7,000 functional tractors for 28 million farmers in Nigeria (1:2:1,120) (Takeshima, 2016; TOHFAN, 2019), underlying the low farm productivity in the country. With the yearning for increased agricultural productivity, increasing the adoption of technology such as UAVs has become imperative. However, understanding the factors influencing the adoption of this technology is important for its successful deployment by drone services companies and policymakers. While external factors such as infrastructure, cost of technology purchase and operation have been highlighted to influence drone adoption by farmers, these restricting factors have also been reported by Skevas & Kalaitzandonakes, 2020. Therefore, this study seeks to understand farmers' perceptions and willingness to adopt drone technology in agriculture in Nigeria. Based on the information at our disposal, our research is the first to explore farmers' perceptions and willingness to adopt drone technology in Nigeria.

MATERIALS AND METHODS

Study area

The study was conducted in Moniya, Ibadan, South-West Nigeria where farmers were administered questionnaires at a farmers' field day to assess their perception and willingness to adopt drone technology in agriculture.

Study design

This study adopted a qualitative exploratory design as a research methodology and a semi-structured questionnaire approach distributed to farmers from the different geographical regions of Nigeria. The questionnaire was subdivided into thematic sections, including socio-demographic characteristics, farmers' perceptions of drone technology, and the factors underlying or impeding farmers' adoption of drone technology.

Sampling and data collection

We employed a purposive sampling method to collect data from 96 respondents, spanning 20 States across Nigeria. The study was conducted between September 20, 2022, and October 14, 2022.

Data analysis

Completed questionnaires were received in hard copy form or via Online format (Google form), coded, entered, and analysed using the Statistical Package for the Social Science (SPSS), version 25.0 for Windows (SPSS Inc., Chicago, Illinois, United States). The analytical approaches used were descriptive statistics such as percentages and frequencies. We examined the variables influencing farmer's willingness to adopt drone technology in agriculture in Nigeria using the binomial logistics regression.

RESULTS AND DISCUSSION

Descriptive statistics

The result of the household survey indicates more male (82.29%) than female (17.71%) respondents, with 48.96% married and 51.04% single. 92.71% of the surveyed households completed tertiary education, 6.25% did not complete secondary education, and 1.04% completed primary education. The average farming experience of the respondents was 2.62 years, and only 29.03%, 9.68%, and 7.53% have been farming for 3, 4, and 5 years, respectively. The major crops grown by the households include cassava (13.04%), maize (13.04%), tomatoes (23.91%), and vegetables (21.74%).

All the respondents have mobile phones, with 98.6% accessing internet connectivity. The respondents' proportion of small, medium, and large-scale farmers was 43.62%, 39.36%, and 17.02%, respectively. Households using overhead irrigation (47.25%) were fewer than those depending on rain-fed agriculture (48.35%), and only 4.4% used both. The recorded income-generating activities include farming (62.86%), logistics (1.43%), trading (21.43%), processing/value addition (5.71%), and others (8.57%). The households' preferred method of pesticide application was a knapsack or manual (68.82%) and motorized backpack sprayers (16.13%).

The application of drones in agriculture includes crop irrigation, pest control, fertilizer application, and animal mustering, among others (Yinka-Banjo and Ajayi, 2019). A higher proportion of the surveyed households have heard about drones (95.74%), compared to 4.26% who are unaware of the technology. This result corroborates the report by Jemali et al. (2017), who reported that 81.4% of the respondents in their study had prior knowledge of drones. However, it is noteworthy that drone awareness differs from the ability to use or offer technical opinions about the technology (Smith et al., 2022). In this sense, understanding the public's awareness of drones can be a complex phenomenon. In this study, the major sources of drone information include social media (61.36%) and websites (19.32%). This concurs with the educational level of the respondents and their inclination toward using social media. A similar result has been reported in the USA (Aydin, 2019) concerning the prominence of the mainstream media as the main source of drone-related information. There was a slight difference in the respondent's experience regarding drone demonstrations and handling. 51.06% of the farmers have experienced drone demos, while 48.94% have yet to have the experience. Only 22.58% have operated a drone, and 77.42% lack the technical know-how to operate a drone. This differs from the report by Annor-Frempong and Akaba (2019) that only 2.8% (4) of farmers had experienced drone technology in a survey conducted in Ghana. Farmers who have experienced drone demonstrations could probably derive technical knowledge from the specialists, which may enhance drone adoption on their farms in the nearest future (Aydin et al., 2019; Hafeez et al., 2022).

Only 38.3% had employed the services of a drone company/expert. In Finland, Simula (2021) reported that 64% of 1 092 farmers were already or willing to use drone services. The low level of drone employment observed in this study may be related to the small and medium scale of farm production undertaken by the larger percentage of the respondents, which

precludes investment in the technology. However, specialized education on precision agriculture could help increase the awareness and adoption of drones in the Nigerian agricultural sector (Uche and Audu, 2021). 92.7% of households are willing to pay for drone services. This corroborates the findings by Omega (2021) that farmers in Northern Ghana are willing to pay for drone services, albeit with varying payment capacities. Based on our results, the government and policymakers need to develop regulatory measures to ensure citizens' safety and privacy as the advocacy for drone use in Nigeria expands (Yawson and Frimpong-Wiafe, 2018).

Majority of the surveyed farmers (98% and 94%) opine that drone technology can help overcome farming challenges and enhance agricultural productivity respectively. Moreover, a higher proportion of the respondents (96.81%) are interested in leveraging drones over the long term, indicating a positive potential for drone piloting services in Nigeria (Simula, 2021). Moreover, the study showed that a large percentage of households (66.67%) prefer drone usage to the conventional method of farming (33.33%), and the most preferred drone service delivery was publicly subsidized service (22.83%), employing drone service as a cooperatives, association or cluster group (20.65%), and direct payment by individual farmers (15.22%). This points to a huge gap in the respondent's knowledge and awareness of the merits of drones in agriculture.

Table 1. Results of the relationship between farmer's socioeconomic and operational activities and willingness to pay for drone technology in Agriculture in Nigeria.

Independent variables	Marginal effect	Coefficient	Std. err.	z	P>|z|
Age	0.009	.1542287	.0769273	2.00	0.045
Gender	0.147	1.582243	.922748	1.71	0.086
Type of agriculture	-0.031	-.5420138	.6522722	-0.83	0.406
Number of incomes	0.002	.0353492	.4656768	0.08	0.939
Education	-0.003	-.0571256	1.458888	-0.04	0.969
Membership of cooperatives	0.072	1.340747	1.228146	1.09	0.275
Credit access	-0.096	-1.12778	1.749141	-0.64	0.519
No. of crops grown	-0.001	-.0237238	.2796799	-0.08	0.932
constant		-2.933122	2.578271	-1.14	0.255

Note: Likelihood ratio chi square = 13.42 (df =), Chi-square probability = 0.0981, and Pseudo R^2 = 0.225. The reference category for gender = female.

Factors affecting farmer's willingness to adopt drone technology in Nigeria

One of the merits of drone application in agriculture is improved productivity at a low cost. In this study, the farmer's age influenced their willingness to adopt drone applications in agriculture, and an increase in age increases the chances of adopting drone-driven precision agriculture. Our result supports the findings by Bai et al. (2022) and Michels et al. (2020) that farmers' age is a driver of drone adoption in farming areas. Like Michels et al. (2020), most of the respondents in our study are youths which may have contributed to their age influence on drone adoption. Another probable reason for the observed result is comfortability with the technology (Klauser et al., 2017).

Farmer's sexual orientation is perceived as less important in the adoption of precision agriculture (Paustian and Theuvsen, 2017), and farming is predominantly dominated by male households in Nigeria (Bello et al., 2021; Aminu et al., 2021). Studies on climate-smart adaptation strategies (e.g., Oyawole et al., 2020) and smart farming and AI (e.g., Foster et al., 2023) showed gender differences in farming technology adoption. We found that male farmers are 1.58 times more likely to adopt drones than their female counterparts. This concurs with

Zheng et al. (2019) and Paustian and Theuvsen (2017), who showed that male households are more inclined to adopt drones, partly due to the higher proportion of male-headed households among the respondents. Unlike Bai et al. (2022), education level did not impact drone adoption, and this may be related to convergence in the respondents' level of education. All other variables considered in the model did not influence drone adoption.

CONCLUSION

This research assessed farmers' awareness of the use and operations of drone technology in enhancing the efficiency of agricultural practices and contributing to sustainable livelihoods in farming areas. Farmers attest to the need for a shift from conventional agriculture to precision farming hinged on the deployment of drone services, thus exemplifying the importance of awareness of drone technology for easy adoption of drone services. Several limiting factors were identified, including the credit worthiness of farm holdings, aggregation of farmers into groups and incentivizing/subsidizing drone services on a public-private partnership, which, if addressed, would help to fast-track adoption at scale. Given the current realities of a race to achieve availability, accessibility, and affordability of safe and nutritious food for all, drone services are strategic in leapfrogging agricultural practices to feed into the overall agri-food systems transformation agenda. With self-sufficiency in food production on the continent of Africa, the findings from this research speak to the need to bridge the gap between technology and agriculture while placing youths in the centre stage to drive the process through R&D, SMEs, and Policy formulation to deliver on the Malabo Declaration, CAADP and AU Agenda 2063

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