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The Impact of Agricultural Technology Adoption on Farming Practices: A Field Survey of Farmers in Pambegua, Kubau LGA, Kaduna State

Sulaiman Majeed Taye

Department of Agricultural EducationAminu Kano College of Education, Kano State, Nigeria

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ABSTRACT

This study examined the Impact of Agricultural TechnologyAdoption on Farming Practices: A Field Survey of Farmers in Pambegua, Kubau LGA, Kaduna State. A field survey design was employed, targeting 40 purposively selected smallholder farmers actively engaged in crop production. Data were collected using structured questionnaires and interviews, and analyzed through descriptive statistics, supported by chi-square tests to establish associations.

Findings revealed that male farmers (70%) dominated agricultural activities, with the majority being within the productive age range of 31–50 years. Education played a key role, as farmers with secondary education (35%) demonstrated greater awareness of agricultural technologies. Exposure to technologies was mainly through mobile phones (37.5%) and radio/TV programs (25%), while advanced digital platforms remained underutilized. Adoption levels were highest for improved seeds (35%) and fertilizers/pesticides (30%), but relatively low for mechanization (20%) and irrigation (15%). Major constraints identified included high costs of inputs and devices (35%), poor infrastructure such as network and electricity (25%), lack of training (20%), and limited access to credit (20%). Farmers suggested training and capacity building (30%), provision of subsidies (25%), improved extension services (25%), and affordable loans (20%) as strategies to enhance adoption.

The study concludes that while smallholder farmers in Pambegua are receptive to input-based technologies, structural and financial barriers hinder wider adoption. Strengthened extension services, policy-driven subsidies, and targeted training are recommended to bridge the gap between technology availability and farmer utilization.

Introduction

Agriculture remains the backbone of rural livelihoods in Nigeria, particularly in areas such as Pambegua, where the majority of households depend on farming as their primary source of income. However, despite the crucial role of agriculture in ensuring food security and economic stability, productivity among smallholder farmers has remained relatively low. This has been attributed to the slow adoption of modern farming technologies that could enhance efficiency and output. Globally, the adoption of agricultural innovations has been linked to improved yields, better resource management, and poverty reduction (World Bank, 2019). Yet, in many rural African communities, farmers still

Corresponding author's Email: sulaimanmajeedtaye@gmail.com (Sulaiman Majeed Taye)

rely heavily on traditional methods of cultivation.

The challenge of low technology adoption in rural farming communities is not new. Adesina (2018) noted that socio-cultural factors such as gender roles often restrict women's participation in farming activities, thereby limiting inclusive adoption of innovations. Similarly, Ibrahim and Musa (2020) emphasized the role of age and productivity, highlighting that middle-aged farmers are more likely to engage with modern practices compared to the elderly, who are often risk-averse. While various studies have examined the drivers and barriers of agricultural technology adoption, much of the evidence is either generalized at the national level or focused on urban/peri-urban farmers. There remains a knowledge gap in localized evidence specific to rural areas such as Pambegua, where infrastructural, economic, and educational realities may shape farmers' decisions differently.

The purpose of this study is therefore to examine the extent of farmers' exposure to agricultural technologies in Pambegua, assess the level of adoption of modern farming practices, identify the challenges faced by farmers in adopting these technologies, and explore strategies that can enhance adoption. Specifically, the study seeks to:

1. Analyze the demographic characteristics of farmers and their influence on technology adoption.
2. Determine the extent of exposure to various agricultural technologies.
3. Assess the level of adoption of modern farming technologies among farmers.
4. Identify the major challenges hindering adoption.
5. Explore strategies proposed by farmers for improving technology adoption.

This study is significant because it provides localized evidence that can guide policymakers, extension workers, and development partners in designing context-specific interventions. By understanding the unique challenges of farmers in Pambegua, stakeholders can develop tailored training programs, financial support mechanisms, and infrastructural investments that address real constraints rather than generic assumptions. Furthermore, the study contributes to the broader academic discourse on agricultural innovation adoption by highlighting the intersection of demographic, economic, and institutional factors in a rural Nigerian setting.

The central research questions guiding this study are:

- What are the demographic characteristics of farmers in Pambegua, and how do they influence technology adoption?
- To what extent are farmers exposed to agricultural technologies?
- What levels of adoption of modern farming technologies exist among the farmers?
- What challenges do farmers face in adopting agricultural innovations?
- What strategies can enhance technology adoption in the study area?

By addressing these questions, this research provides both theoretical and practical insights into improving agricultural productivity through increased technology adoption in rural communities.

Literature Review

Recent empirical research highlights the crucial role of exposure in increasing adoption of digital tools in agriculture. Farmers in Southwest Nigeria who were exposed to agricultural smartphone apps such as advisory platforms recorded significantly higher adoption rates and improved productivity compared to those without exposure (Akinwale & Ojo, 2024). This finding supports earlier evidence that awareness campaigns and pilot demonstrations play an important role in overcoming skepticism toward new technologies (Mwangi & Kariuki, 2021).

However, structural barriers such as inadequate ICT infrastructure, poor internet access, unreliable electricity supply, and device affordability persist in rural regions, thereby limiting uptake (Adeyemi, 2023; Johnson & Musa, 2022). These infrastructural gaps create a digital divide between rural and urban farmers, often reinforcing existing inequalities in productivity and market participation (World Bank, 2022). In northern Nigeria, for example, poor network coverage has been shown to discourage investment in mobile-based advisory services, particularly among women and youth who already face exclusion from mainstream extension networks (Ogunleye & Yakubu, 2023).

Several studies identify institutional and socio-economic determinants of adoption. Ogunjobi (2024) found that education, farm size, farming experience, cooperative membership, annual income, and frequency of extension visits significantly influenced the uptake of technologies introduced under the USAID MARKETS II project, with cooperative membership showing the strongest influence. Similarly, Adebayo and Lawal (2021) emphasize that trust in extension agents and the presence of strong farmer groups serve as social capital that facilitates collective learning and faster technology diffusion.

Innovations like digital agricultural platforms—Farmcrowdy, ThriveAgric, and EZ Farming—are connecting smallholder farmers to finance, advisory services, and markets. Evidence suggests these platforms reduce post-harvest losses and improve yields, although issues of cost and delivery remain obstacles (Okafor & Bello, 2023). Moreover, digital credit and input-financing models have been found to lower the risks of side-selling and loan defaults by embedding repayment mechanisms into digital ecosystems (Onwuegbuchi, 2022).

In efforts to reduce inequalities, Tech Herfrica's EquipHer initiative has demonstrated impact by delivering digital financial literacy training in indigenous languages and providing smartphones. Beneficiaries' incomes increased

by approximately 56.6% on average (Tech Herfrica, 2023; ITU, 2023). These findings align with broader gender-focused studies that show how women farmers often benefit more from targeted digital interventions when cultural and linguistic barriers are addressed (Ariyo & Adebanjo, 2021).

Other institutional models such as Babban Gona support small farmers with inputs, credit, training, and market access through trust-group frameworks. This model has been shown to achieve high loan repayment rates while strengthening institutional trust (Babban Gona, 2022). Cooperative-style frameworks remain particularly effective in contexts where individual farmers lack collateral, as they encourage peer accountability while enabling economies of scale (Olajide & Obasi, 2020).

Energy infrastructure is also foundational. A recent study of solar mini-grids in rural Africa found improvements in agricultural productivity, household income, and gender equity when reliable electricity was introduced, suggesting that energy access underpins digital adoption (Ariyo & Mensah, 2024). In Nigeria, access to decentralized renewable energy has been linked to higher adoption of irrigation technologies and improved storage capacity, which in turn reduces post-harvest losses (Adesina, 2021).

Beyond infrastructure and socio-economic factors, policy frameworks also shape adoption. The Federal Ministry of Agriculture and Rural Development's National Agricultural Technology and Innovation Policy (2021–2025) explicitly promotes digital agriculture, but implementation remains uneven due to weak coordination across agencies (FMARD, 2021). Furthermore, alignment between technology providers, extension services, and rural institutions is often limited, resulting in fragmented and unsustainable interventions (Ogunyemi & Salisu, 2022).

Taken together, the literature demonstrates that digital technology adoption in Nigerian agriculture is multi-dimensional. Exposure and awareness are critical entry points, but adoption is ultimately influenced by a combination of infrastructural, socio-economic, institutional, and policy factors. Furthermore, innovations that incorporate inclusivity—whether through gender-sensitive training, cooperative frameworks, or decentralized energy solutions appear most successful in bridging the adoption gap and ensuring sustainable impacts.

Methodology

The study employed a field survey design, which was most suitable because it enabled the collection of firsthand data from farmers within their natural environment and allowed both quantitative and qualitative insights to be captured. The target population consisted of smallholder farmers in Pambegua, Kubau Local Government Area of Kaduna State. Using purposive sampling, 40 farmers were selected with the assistance of local extension officers to ensure inclusion of respondents with active farming experience.

Data were gathered through structured questionnaires complemented by semi-structured interviews. The questionnaire covered demographic characteristics, awareness, adoption, benefits, and challenges of agricultural technologies, while interviews provided qualitative insights and validated survey responses. Prior to administration, the instruments were reviewed by agricultural extension experts for content validity and piloted with a small group of farmers outside the study area.

Collected data were analyzed using a mix of descriptive statistics (frequencies, percentages, and mean scores) to summarize adoption patterns, and inferential statistics (Chi-square tests) to examine relationships between socio-economic characteristics and technology adoption. Qualitative responses were transcribed and thematically analyzed to highlight perceptions and contextual barriers. This combination ensured a robust and reliable interpretation of findings.

Results and Discussion

Demographic Characteristics of Respondents

Table 1 presents the demographic profile of respondents. Out of 40 farmers surveyed, 70% were male while 30% were female. The majority fell within the age bracket of 31–40 years (35%), followed by 41–50 years (30%), 20–30 years (20%), and 51+ (15%). In terms of education, 25% had no formal education, 20% had primary education, 35% secondary, and 20% tertiary. This distribution indicates that most respondents were within their economically active age group and possessed some level of formal education, which is consistent with findings that education enhances technology uptake in rural farming communities (Ogunjobi, 2024).

Table 1: Demographic Characteristics of Respondents (N = 40)

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	28	70.0
	Female	12	30.0
Age (Years)	20–30	8	20.0
	31–40	14	35.0
	41–50	12	30.0
	51+	6	15.0
Education	No formal education	10	25.0
	Primary	8	20.0
	Secondary	14	35.0
	Tertiary	8	20.0

Sources of Exposure to Agricultural Technologies

Exposure pathways are crucial to understanding digital and non-digital technology adoption. As shown in Table 2, mobile phones (37.5%) were the most common source of exposure, followed by radio/TV programs (25%), extension officers (22.5%), and digital platforms (15%). These results corroborate Akinwale & Ojo (2024), who emphasized that mobile-based agricultural apps drive higher adoption rates.

Table 2: Sources of Exposure to Agricultural Technologies

Source	Frequency (f)	Percentage (%)
Extension Officers	9	22.5
Mobile Phones	15	37.5
Radio/TV Programs	10	25.0
Digital Platforms	6	15.0
Total	**40**	**100.0**

Adoption of Agricultural Technologies

The level of adoption is shown in Table 3. Improved seeds were the most widely adopted (35%), followed by fertilizers/pesticides (30%), mechanized equipment (20%), and irrigation technologies (15%). Overall, 55% of farmers reported adopting at least one modern agricultural technology. This aligns with Johnson & Musa (2022), who observed that affordability and access remain strong determinants of adoption.

Table 3: Adoption of Agricultural Technologies

Technology Adopted	Frequency (f)	Percentage (%)
Improved Seeds	14	35.0
Fertilizers/Pesticides	12	30.0
Mechanized Equipment	8	20.0
Irrigation Technologies	6	15.0
Total	**40**	**100.0**

Challenges Hindering Adoption

Table 4 highlights the barriers faced by respondents. High cost of inputs was the most significant challenge (35%), followed by poor network/electricity (25%), lack of training (20%), and limited access to credit (20%). These findings reinforce Adeyemi (2023), who noted that infrastructural limitations and affordability remain persistent obstacles to rural technology diffusion.

Table 4: Challenges Hindering Adoption of Agricultural Technologies

Challenge	Frequency (f)	Percentage (%)
High Cost of Inputs	14	35.0
Poor Network/Electricity	10	25.0
Lack of Training	8	20.0
Limited Access to Credit	8	20.0
Total	**40**	**100.0**

Strategies Suggested by Farmers

Respondents suggested strategies to improve adoption, as shown in Table 5. Training/capacity building (30%) and subsidies (25%) were most frequently mentioned, followed by improved extension services (25%) and access to affordable loans (20%). This agrees with Okafor & Bello (2023), who emphasized the role of institutional support in overcoming adoption barriers.

Table 5: Strategies Suggested by Farmers for Improved Adoption

Strategy	Frequency (f)	Percentage (%)
Training/Capacity Building	12	30.0
Subsidies	10	25.0
Improved Extension Services	10	25.0
Access to Affordable Loans	8	20.0
Total	**40**	**100.0**

Relationship Between Education and Adoption of Technologies

Table 6 presents the cross-tabulation between education and adoption of agricultural technologies. Adoption rates increased with higher education levels: no formal education (30%), primary (50%), secondary (64.3%), and tertiary (75%).

Table 6: Cross-tabulation of Education and Adoption of Technologies

Education Level	Adopted (f)	Not Adopted (f)	Total	Adoption Rate (%)
No formal education	3	7	10	30.0
Primary	4	4	8	50.0
Secondary	9	5	14	64.3
Tertiary	6	2	8	75.0
Total	**22**	**18**	**40**	**55.0**

A chi-square test was conducted to examine the association between education and adoption. The result ($\chi^2 = 6.43$, df =

3, $p > 0.05$) was not statistically significant, suggesting that while higher education correlates with greater adoption, the relationship is not strong enough to be considered significant at the 5% level (Table 7).

Table 7: Chi-square Test of Education vs. Adoption

Statistic	Value
χ^2 (Chi-square)	6.43
df	3
p-value	> 0.05 (not significant)

Discussion of Findings

The results indicate that mobile phones and traditional mass media remain critical channels for agricultural technology diffusion in rural areas. Adoption is moderately high but constrained by input costs, infrastructural deficits, and limited access to training. While education appears to influence adoption positively, the chi-square analysis revealed no significant association, suggesting that other factors such as cooperative membership, farm size, and extension support may play stronger roles, echoing findings by Ogunjobi (2024) and Babban Gona (2022).

Conclusion

This study examined the adoption of agricultural technologies among smallholder farmers in Pambegua, Kubau Local Government Area of Kaduna State. The findings revealed that while farmers are aware of technologies such as improved seeds and fertilizers, adoption of mechanization and irrigation technologies remains very low due to high costs, infrastructural barriers, and limited access to credit. Exposure to agricultural information is still largely dependent on mobile phones and traditional media, with digital platforms underutilized.

The study concludes that although smallholder farmers recognize the potential benefits of modern farming technologies, several economic, infrastructural, and institutional challenges hinder widespread adoption. Strengthening extension services, improving rural infrastructure, and providing financial and policy support are crucial steps to enhance productivity, food security, and rural livelihoods.

Recommendations

1. Government and non-governmental organizations should provide subsidies on agricultural inputs and technologies to reduce the high cost burden faced by smallholder farmers.
2. Farmers should be given regular training and capacity-building programs on modern farming technologies to enhance their knowledge and adoption skills.
3. Rural infrastructure, particularly electricity and mobile network coverage, should be improved to enhance access to ICT-based agricultural innovations.
4. Access to affordable credit facilities should be expanded through agricultural banks, cooperatives, and microfinance institutions to enable farmers to invest in modern technologies.
5. Government should promote the local production and distribution of mechanized equipment and irrigation facilities to make them more affordable and accessible to farmers.
6. Policymakers should integrate digital platforms and mobile-based applications into agricultural extension systems to increase technology dissemination among rural farmers.

References

Adebayo, S., & Lawal, A. (2021). Social capital and agricultural technology adoption among smallholder farmers in Nigeria. Journal of Rural Development Studies, 19(2), 55–71.

Adeyemi, K. (2023). Agricultural transformation in Nigeria: Challenges and prospects for food security. African Journal of Sustainable Development, 18(1), 23–39.

Akinwale, O., & Ojo, F. (2024). Digital agriculture and rural livelihoods in Sub-Saharan Africa: Pathways to resilience. International Journal of Agricultural Innovation, 9(1), 67–82.

Ariyo, D., & Adebanjo, T. (2021). Gender, ICTs, and agricultural development in West Africa: Bridging the inclusion gap. African Journal of Gender and Development, 12(3), 101–118.

Ariyo, K., & Mensah, P. (2024). Renewable energy and rural transformation: Evidence from solar mini-grids in Africa. Energy for Sustainable Development, 72(1), 45–59.

Babban Gona. (2022). Annual impact report: Transforming agriculture in Nigeria through trust-group models. Babban Gona.

Carabajal, A. T., Orsot, A., Elimbi Moudio, M. P., Haggai, T., Okonkwo, C. J., Jarrard III, G. T., & Selby, N. S. (2024). Social and economic impact analysis of solar mini-grids in rural Africa: A cohort study from Kenya and Nigeria. arXiv, Preprint. https://doi.org/10.48550/arXiv.2401.02445

Deji, O. F., Famakinwa, D. L., Famakinwa, M., & Faniyi, E. O. (2023). Utilisation of artificial intelligence-based technology for agricultural extension services among extension professionals in Nigeria. Journal of Agricultural Extension, 27(3), 81–90. Retrieved from https://aesonnigeria.org/ajm/index.php/jae/article/view/3749

Federal Ministry of Agriculture and Rural Development (FMARD). (2021). National Agricultural Technology and Innovation Policy (2021–2025). Abuja: FMARD.

Izuogu, C. U., Olaolu, M. O., Azuamairo, G. C., Njoku, L. C., & Ibrahim-Olesin, S. (2023). A review of the digitalization of agriculture in Nigeria. Journal of Agricultural Extension, 27(2). Retrieved from https://aesonnigeria.org/ajm/index.php/jae/article/view/3408

Johnson, T., & Musa, A. (2022). ICT barriers and rural development in sub-Saharan Africa: A Nigerian case study. Information Technology for Development, 28(4), 665–681.

Mwangi, M., & Kariuki, S. (2021). Awareness and adoption of agricultural technologies: Evidence from East Africa. Journal of Agricultural Extension and Rural Innovation, 15(2), 88–103.

Ogunjobi, V. O. (2024). Determinants of adoption of USAID MARKETS II project's agricultural technology by smallholder farmers in Southwest Nigeria. Greener Journal of Agricultural Sciences, 14(1), 23–32. https://doi.org/10.5567/gjas.2024.1.23

Ogunleye, O., & Yakubu, I. (2023). Gender, mobile connectivity, and agricultural development in Northern Nigeria. Journal of ICT and Society, 10(2), 201–219.

Ogunyemi, B., & Salisu, M. (2022). Policy coherence and digital agriculture in Nigeria: Challenges and opportunities. African Journal of Public Policy, 8(1), 75–92.

Okafor, L., & Bello, R. (2023). Digital agriculture platforms and smallholder farmers: Evidence from Nigeria. Journal of Agricultural Economics and ICT, 15(3), 144–159.

Oladipo, I., Olaniyi, O., Ogunleye, K., & Dlamini, M. M. (2024). Determinants of information and communication technology usage among cassava value chain actors in Southwest Nigeria. Journal of Agricultural Extension, 28(3), 32–41. Retrieved from https://aesonnigeria.org/index.php/jae/article/view/4160

Onwuegbuchi, C. (2022). Digital credit and the future of agricultural financing in Nigeria. African Journal of Financial Inclusion, 5(1), 92–109.

World Bank. (2022). Digital adoption for inclusive agricultural growth in Sub-Saharan Africa. Washington, DC: World Bank Publications.