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Participation in WhatsApp and Facebook Farmer Groups and Adoption of Smart Agriculture Techniques among Smallholder Farmers

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Abstract
This study investigated the relationship between participation in WhatsApp and Facebook farmer groups and the adoption of smart agriculture techniques among smallholder farmers in Oyo State. A cross-sectional survey of 392 farmers across three agricultural zones was conducted over five months using structured questionnaires. Data were analysed with descriptive statistics, Chi-square tests, and multiple regression. Findings revealed that 71.2% of farmers used WhatsApp groups, 48.5% used Facebook, and 34.4% used both platforms. Farmers with high participation (daily/weekly) adopted an average of 8.7 smart practices, compared to 2.3 among low-participation farmers, indicating a significant adoption gap of 36.3 percentage points ($\chi^2 = 156.82$, $p < 0.001$). The practices included mobile-based advisory services, weather-informed decision-making, pest forecasting, fertilizer micro-dosing, improved seed access, and variable-rate input application. Regression results showed that participation frequency ($\beta = 0.468$), information quality ($\beta = 0.412$), and digital confidence ($\beta = 0.321$) significantly influenced adoption ($R^2 = 0.681$). Key barriers identified were poor internet connectivity (67.3%), high data costs (62.1%), low trust in online information (58.7%), and limited smartphone capacity (51.8%). The study concludes that social media platforms are effective tools for promoting smart agriculture, though their impact depends on content quality, digital literacy, and improved infrastructure.

Keywords: WhatsApp, Facebook, smart agriculture, precision agriculture, smallholder farmers

1. Introduction

Nigeria's agricultural sector constitutes approximately 24-28% of the nation's GDP and employs over 70% of the rural population, yet smallholder farmers face mounting challenges of declining soil productivity, climate variability, pest outbreaks, and limited market access (Ogunleye and Adeyemi, 2023; Oladipo and Okon, 2024). Traditional extension systems, though established, reach only a fraction of the 14.5 million smallholder farmers dispersed across Nigeria's diverse agro-ecological zones (National Bureau of Statistics, 2023). Smart agriculture which is the integration of digital information platforms, data-driven decision support tools, and technology-enhanced agronomic practices that optimize resource use and improve farm productivity, offers unprecedented opportunities for productivity enhancement and climate resilience (FAO, 2023). This definition encompasses both purely digital technologies (mobile apps, sensor-based monitoring, digital advisory services) and information-intensive agronomic innovations (improved seed varieties accessed through digital catalogues, precision input application informed by digital recommendations, climate-smart practices disseminated via digital channels), reflecting the continuum of technology adoption facilitated through social media platforms (Nigeria Digital Agriculture Strategy, 2020; Wolfert et al., 2020). Smart agriculture techniques have demonstrated substantial yield and income improvements in pilot studies across Nigeria (Kolapo and Didunyemi, 2024; Fabregas et al., 2024).

However, adoption of these techniques remains constrained by high equipment costs, poor digital infrastructure, limited technical skills, and farmer skepticism (Abate et al., 2023; Choruma et al., 2024). Simultaneously, mobile phone ownership and social media use have expanded dramatically in rural Nigeria, with WhatsApp and Facebook emerging as primary channels through which farmers communicate, exchange experiences, and access agricultural information (Williams et al., 2025; Chinedu and Bello, 2024). Recent estimates indicate that 52.3% of Nigerian farmers use WhatsApp and 41.7% use Facebook for agricultural purposes, often within active farmer groups (Ugbome et al., 2026). These farmer groups represent organic, peer-led networks where knowledge is shared through photos, videos, voice messages, and text, a communication modality well-suited to farmers with varying literacy levels and time constraints (Mulaudzi et al., 2024). Preliminary evidence suggests that active participation in such groups correlates with higher adoption of agricultural innovations, particularly when information is timely, locally relevant, and practically demonstrated (Fue et al., 2025; Ferguson et al., 2024). Yet the specific relationship between farmer group participation intensity, information quality within these groups, and adoption of smart agriculture techniques remains empirically underexplored in the Nigerian context.

Despite the growing proliferation of farmer WhatsApp and Facebook groups, several knowledge gaps persist. First, while presence in farmer groups is increasingly documented, detailed data on participation patterns such as frequency of interaction, duration of engagement, and types of contributions remain limited, especially in rural areas with heterogeneous digital infrastructure. Second, few studies quantify the extent to which smart agriculture information and techniques (for example, precision input use, digital advisory tools, sensor-based monitoring) are actively shared, discussed, and promoted within Nigerian farmer groups, as opposed to general agricultural or social talk. Third, the quality and credibility of smart agriculture content disseminated through WhatsApp and Facebook groups, its accuracy, completeness, and farmers' perception of trustworthiness are poorly understood, raising questions about misinformation and risk perceptions. Finally, how individual farmer characteristics (age, education, farm size, income, digital literacy), group dynamics (group size, leadership quality, moderation practices), and information attributes (content clarity, local relevance, visual demonstration) interact to influence smart practice adoption via these channels remains unclear. Finally, barriers specific to social media-enabled smart agriculture adoption such as platform-related connectivity constraints, data costs, digital confidence, trust in online peers, and peer influence that may either facilitate or hinder adoption have not been systematically documented and analysed in rural Nigerian settings. The objectives of the study are:

i. To assess the levels and patterns of participation in WhatsApp and Facebook farmer groups among Nigerian smallholder farmers and characterize the types of smart agriculture information shared.
ii. To examine the relationship between frequency and intensity of participation in WhatsApp and Facebook farmer groups and adoption of smart agriculture techniques.
iii. To identify factors mediating the impact of group participation on smart practice adoption.
iv. To identify barriers constraining effective use of WhatsApp and Facebook farmer groups for smart agriculture technology diffusion.

The following research hypothesis were also formulated to guide the study:

H_{01}: There is no significant relationship between frequency of participation in WhatsApp/Facebook farmer groups and adoption of smart agriculture techniques.

H_{02}: Information quality within farmer groups does not significantly influence farmers' confidence in adopting smart agriculture practices accessed through social platforms.

2.0 Materials and methods
2.1 Method of Data Collection

A cross-sectional survey design was employed to investigate farmer participation in WhatsApp and Facebook groups and the adoption of smart agriculture techniques at a defined time period in the agroecological zones of Oyo State, Southwestern Nigeria. This design allows cost-effective data collection from a relatively large sample of smallholder farmers within distinct production environments and enables the examination of associations between participation in social media groups and smart agriculture adoption without experimental manipulation (McQuail, 2021).

The study was conducted in the main agroecological zones of Oyo State, which are characterised by mixed cropping systems and varying levels of market access and digital connectivity. The three agricultural zones in the state were covered: the derived savanna and forest-savanna transition belt (Iseyin and Saki), the humid forest and peri-urban vegetable belt (Ibadan) and the lowland and inland valley ecologies (Oyo, Ogbomoso). These agroecological zones were purposively selected to capture intra-state geographic diversity, differences in farming systems, and variation in digital infrastructure and social media penetration among farmers in Oyo State. The target population comprised smallholder farmers cultivating less than 5 hectares who are actively engaged in crop production and participate in at least one WhatsApp or Facebook farmer group focused on agricultural activities, with the eligible population running into several hundreds of thousands based on National Bureau of Statistics (2023) estimates and state Agricultural Development Programme records.

Sample size determination followed Yamane's (1967) formula for finite populations at a 95% confidence level and 5% margin of error, as applied in similar digital agriculture studies. Given the large size of the eligible smallholder farmer population in Oyo State, the resulting minimum required sample was approximately 400 respondents, and after data cleaning and removal of incomplete questionnaires, 392 valid responses were retained for analysis, yielding a response rate of about 98%. A multi-stage sampling technique was adopted to ensure representativeness. First, three major agroecological/production belts within Oyo State were purposively selected based on agricultural significance and variation in digital infrastructure. Second, two Local Government Areas (LGAs) with high agricultural activity were randomly selected from each belt (six LGAs in total). Third, active WhatsApp and Facebook farmer groups in the selected LGAs were identified Fourth, proportionate stratified random sampling of farmers from confirmed group membership lists was carried out. Finally, simple random sampling of individual respondents within each stratum was used to achieve the sample size of 392 smallholder farmers.

The study instrument was a structured questionnaire titled *"WhatsApp/Facebook Farmer Groups and Smart Agriculture Questionnaire" (WFFSAQ)*, consisting of six sections covering socio-demographic characteristics, social media access, participation patterns, exposure to smart agriculture information, adoption of key smart techniques, and barriers and trust factors. The questionnaire combined close-ended, multiple-choice, and Likert-scale items, with visual aids for respondents with limited literacy. It was validated by experts and pilot-tested with 45 farmers, yielding a Cronbach's alpha of 0.89. Data were collected through face-to-face interviews by trained research assistants between April and August 2025.

2.2 Method of Data Analysis

Data analysis was conducted using IBM SPSS Statistics Version 27.0. Descriptive statistics summarised key variables, while chi-square tests, one-way ANOVA, and multiple regression were used to test hypotheses and examine relationships among participation, information quality, digital confidence, and smart agriculture adoption, with effect sizes computed to assess practical significance.

Model Specification

Multiple regression model to predict smart agriculture adoption score:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where:

- Y = Smart Agriculture Practices Adoption Score
- X_1 = Frequency of WhatsApp/Facebook group participation
- X_2 = Information quality score
- X_3 = Farmer digital confidence
- X_4 = Group size and leadership quality
- X_5 = Peer influence and trust in group information
- β_0 = Constant
- β_1, β_2, β_3, β_4, β_5 = Regression coefficients
- ε = Error term

3.0 Result and Discussion

3.1 Socio-Demographic Characteristics of Respondents

Table 1: Socio-demographic Characteristics of the Respondents

Variable	Frequency	Percentage (%)
Gender		
Male	245	62.5
Female	147	37.5
Age Group		
18-35 years	74	18.9
36-50 years	169	43.1
51-65 years	102	26.0
Above 65 years	47	12.0
Education		
No Formal Education	66	16.8
Primary Education	140	35.7
Secondary Education	137	34.9
Tertiary Education	49	12.6
Farm Size		
Below 1 hectare	36	9.2
1-3 hectares	244	62.2
3-5 hectares	112	28.6
Monthly Household Income		
Below ₦50,000	191	48.7
₦50,000-₦100,000	141	35.9
Above ₦100,000	60	15.4
Farming Experience		
5-10 years	108	27.6
11-20 years	175	44.6
Above 20 years	109	27.8

Source: Field Survey, (2025).

Table 1 presents socio-demographic profiles of the 392 respondents. Male farmers (62.5%) constituted the majority, reflecting gender patterns in Nigerian smallholder agriculture, though female representation (37.5%) was substantially higher than in technology adoption studies, reflecting the growing role of women in agricultural groups. Mean age was 44.1 years (SD = 12.3), with largest representation in the 36-50 age bracket (43.1%), followed by 51-65 years (26.0%). This middle-aged demographic reflects the most economically active and farm-operational farmers, contrasting with higher youth migration to urban areas. Educational attainment showed: 16.8% with no formal education, 35.7% with primary education, 34.9% with secondary education, and 12.6% with tertiary education, indicating moderate literacy levels with implications for digital app usability and information interpretation. Farm sizes ranged widely: 9.2% below 1 hectare, 62.2% between 1-3 hectares (modal category), and 28.6% between 3-5 hectares, consistent with smallholder farming definitions. Mean farming experience was 17.1 years, suggesting substantial agricultural knowledge and established community networks facilitating group membership. Monthly household income varied: 48.7% earned below ₦50,000, 35.9% earned ₦50,000-₦100,000, and 15.4% earned above ₦100,000, which shows economic constraints limiting technology investment and mobile data affordability among resource-poor segments.

3.2 Participation in WhatsApp and Facebook Farmer Groups

Table 2: Participation Patterns in WhatsApp and Facebook Farmer Groups

Variable	Category	Frequency	Percentage
WhatsApp Participation			
Participation Status	Yes	279	71.2
	No	113	28.8
Facebook Participation			
Participation Status	Yes	190	48.5
	No	202	51.5
Frequency of WhatsApp Use			
Frequency	Daily	107	38.3
	Weekly	90	32.3
	Monthly	54	19.4
	Rarely	28	10.0
Frequency of Facebook Use			
Frequency	Daily	43	22.6
	Weekly	54	28.4
	Monthly	53	27.9
	Rarely/Never	40	21.1
Discussion Topics in Groups (Multiple Responses)			
Topics	Agronomic techniques/crop problems	309	78.9
	Pest and disease management	281	71.6
	Market prices and sales coordination	228	58.3
	Input sourcing and costs	204	52.1
	Weather updates/forecasting	175	44.7
	Financial services/credit access	146	37.2
	Smart agriculture/precision techniques	123	31.4

Source: Field Survey, (2025).

Table 2 documents farmer engagement with social media platforms. WhatsApp farmer group participation was highest: 71.2% (279 farmers) participated in at least one WhatsApp group. Facebook farmer group participation was lower with 48.5% (190 farmers) who participated. Frequency of participation revealed that 38.5% of WhatsApp group members engaged daily, 32.1% weekly, 19.4% monthly, and 10.0% rarely indicating substantial engagement. For Facebook, daily engagement was lower (22.6%), with weekly participation at 28.4%, monthly at 27.9%, and rare/never at 21.1%, reflecting WhatsApp's role as primary platform. Types of discussions within farmer groups (multiple responses) included: agronomic techniques and crop problems (78.9%), pest and disease management (71.6%), market prices and sales coordination (58.3%), input sourcing and costs (52.1%), weather updates and forecasting (44.7%), financial services and credit access (37.2%), and smart agriculture/precision techniques (31.4%). The relatively lower proportion discussing smart agriculture (31.4%) suggests that while these groups serve important agricultural functions, dedicated attention to precision agriculture remains limited.

3.3 Smart Agriculture Information Exposure and Adoption

Table 3: Adoption of Smart Agriculture Techniques by Participation Intensity

Smart Agriculture Technique	Adoption Rate (%)		Gap
	High Part.	**Low Part.**	**(%)**
Improved Seed Varieties	87.3	44.6	42.7
Weather-Informed Decision-Making	72.6	25.6	47.0
Micro-Dosing of Fertilizers	71.6	31.3	40.3
Mobile Extension Advisory Services	58.9	19.0	39.9
Precision Pest Forecasting	54.3	16.4	37.9
Yield Recording Apps	51.3	13.3	38.0
Push-Pull Technology	48.2	14.4	33.8
Climate Forecast Interpretation	42.6	14.4	28.2
Precision Fertilizer Recommendations	38.3	11.5	26.8

Variable-Rate Input Application	36.5	8.2	28.3
Mean Adoption Rate	**56.2**	**19.9**	**36.3**

Source: Field Survey, (2025).

Table 3 indicates a strong association between participation intensity in farmer groups and the adoption of smart agriculture techniques. Farmers in the high-participation group adopted an average of 8.7 techniques compared with only 2.3 techniques among low-participation farmers, reflecting a wide adoption disparity. The mean adoption rate was 56.2% for high-participation farmers and 19.9% for low-participation farmers, with an average gap of 36.3 percentage points, demonstrating that active group engagement substantially enhances exposure to and uptake of smart practices.

Across individual techniques, the largest adoption gaps were observed for weather-informed decision-making, improved seed varieties, and micro-dosing of fertilizers, each exceeding 40 percentage points. High-participation farmers consistently recorded higher adoption across all techniques, including mobile extension services, precision pest forecasting, and yield recording apps, while more specialized practices such as variable-rate input application showed lower uptake but still benefited from frequent group interaction. These results confirm the important role of sustained group participation in accelerating the diffusion of smart agriculture innovations.

3.4 Hypothesis Testing

3.4.1 Hypothesis One: Participation Frequency and Smart Practice Adoption

H_{01}: There is no significant relationship between frequency of participation in WhatsApp/Facebook farmer groups and adoption of smart agriculture techniques.

Table 4: Chi-Square Analysis: Participation Frequency and Smart Agriculture Adoption

Participation/Frequency	Low (0-5)	Medium (6-10)	High (11-15)	Total
Daily	7 (4.0%)	62 (35.8%)	104 (60.1%)	173
Weekly	13 (12.1%)	53 (49.5%)	41 (38.3%)	107
Monthly	24 (42.9%)	26 (46.4%)	6 (10.7%)	56
Rarely/Never	50 (89.3%)	6 (10.7%)	0 (0.0%)	56
Total	**94**	**147**	**151**	**392**

Source: Field Survey, (2025).

The chi-square test revealed a highly significant association between participation frequency and smart agriculture adoption ($\chi^2 = 156.82$, df = 6, $p < 0.001$), leading to rejection of the null hypothesis. Among daily participants, 60.1% exhibited high adoption levels (11-15 techniques), compared with none of the farmers who rarely or never participated. In contrast, 89.3% of rare or non-participants recorded low adoption (0-5 techniques), compared with only 4.0% among daily participants. This pronounced stratification demonstrates that consistent engagement in farmer groups is a powerful predictor of the breadth of smart agriculture adoption.

3.4.2 Hypothesis Two: Information Quality and Adoption Confidence

H_{02}: Information quality within farmer groups does not significantly influence farmers' confidence in adopting smart agriculture practices accessed through social platforms.

Table 5: ANOVA: Information Quality and Adoption Confidence

Information Quality Level	N	Mean Confidence	SD	Min	Max
Low (0-7)	134	3.2	1.4	1	6
Moderate (8-14)	163	6.1	1.8	4	9
High (15-20)	95	8.4	1.3	6	10
Total	392	5.9	2.4	1	10

Source: Field Survey, (2025).

Table 5 shows that adoption confidence increased markedly with higher information quality, rising from a mean of 3.2 among farmers exposed to low-quality information to 6.1 for those with moderate-quality information and 8.4 for those receiving high-quality information. The ANOVA revealed a highly significant difference among the three groups ($F = 298.47$, $p < 0.001$) with a large effect size ($\eta^2 = 0.605$), indicating that information quality explained over 60% of the variation in adoption confidence. Post-hoc comparisons confirmed that all group differences were significant, demonstrating that exposure to high-quality information substantially enhances farmers' confidence in adopting smart agriculture practices.

3.5 Multiple Regression Analysis

Table 6: Multiple Regression: Predictors of Smart Agriculture Adoption

Predictor Variable	β (Std.)	B (Unstd.)	SE	t-value	p-value
Constant	-	0.89	0.43	2.07	0.039
Participation Frequency (X_1)	0.468	1.12	0.09	12.44	<0.001
Information Quality (X_2)	0.412	0.68	0.06	11.33	<0.001
Digital Confidence (X_3)	0.321	0.54	0.08	6.75	<0.001
Group Characteristics (X_4)	0.189	0.42	0.11	3.82	<0.001
Peer Trust (X_5)	0.156	0.38	0.12	3.17	0.002
Multiple R = 0.825					
R^2 = 0.681					
Adjusted R^2 = 0.674					
Standard Error = 1.96					
F-statistic = 186.42, $p < 0.001$					

Source: Field Survey (2025).

The multiple regression analysis revealed a highly significant model ($F = 186.42$, $p < 0.001$) with strong explanatory power, as the five predictors jointly explained 68.1% of the variance in smart agriculture adoption ($R^2 = 0.681$, Adjusted $R^2 = 0.674$). Participation frequency emerged as the strongest predictor ($\beta = 0.468$), followed by information quality ($\beta = 0.412$) and digital confidence ($\beta = 0.321$), while group characteristics ($\beta = 0.189$) and peer trust ($\beta = 0.156$) also contributed significantly. These findings indicate that frequent engagement, high-quality information, and farmers' digital competence are the primary drivers of smart agriculture adoption, with supportive group structure and peer trust further strengthening adoption decisions.

3.6 Barriers to Smart Agriculture Adoption via Social Media Groups

Table 7: Barriers to Smart Agriculture Adoption via Social Media

Barrier	Frequency	%
Inconsistent Internet Connectivity	264	67.3
High Data Costs	243	62.0
Low Confidence in Online Info	230	58.7
Inadequate Smartphone Features	203	51.8
Misinformation in Groups	198	50.5
Lack of Digital Skills	187	47.7
Group Leadership Issues	164	41.8
Device Affordability	171	43.6
Electricity Supply Unreliability	209	53.3
Time Constraints for Participation	138	35.2
Language Barriers in Posts	126	32.1
Privacy/Data Security Concerns	94	24.0

Source: Field Survey (2025).

Table 7 shows that infrastructural constraints were the most prominent barriers to smart agriculture adoption via social media, with inconsistent internet connectivity (67.3%), high data costs (62.0%), and unreliable electricity supply (53.3%) ranking highest. Digital-related challenges were also substantial, including low confidence in online information (58.7%), inadequate smartphone features (51.8%), and lack of digital skills (47.7%), while misinformation in groups (50.5%) and group leadership issues (41.8%) reflected weaknesses in information quality and moderation. Socio-economic and social barriers such as device affordability, time constraints, language difficulties, and privacy concerns were less severe but still notable, indicating that both infrastructural and human factors jointly limit the effective use of social media for smart agriculture adoption.

3.7 Discussion of Findings

The socio-demographic characteristics of respondents provide important context for understanding participation and adoption patterns. The predominance of male farmers reflects established gender patterns in Nigerian smallholder agriculture, though the relatively high female representation suggests growing inclusion of women in agricultural group activities (Ogunyemi and Ajayi, 2021). The middle-aged demographic profile, coupled with moderate education levels and extensive farming experience, indicates a population capable of interpreting and applying new agricultural information. However, the low household income levels observed among nearly half of respondents highlight financial constraints that may limit investment in capital-intensive smart agriculture technologies and mobile data, underscoring the need for platforms to deliver locally appropriate, simple, and visually supported content (FAO, 2023).

The finding that WhatsApp serves as the dominant platform for farmer information exchange, far outpacing Facebook, is consistent with broader trends in rural African digital communication (Williams et al., 2025). WhatsApp's simpler interface, lower data consumption, and integration with existing social networks make it more accessible for farmers with varying digital literacy levels. Importantly, while these farmer groups serve multiple agricultural functions, the relatively low proportion of discussions focused specifically on smart agriculture techniques suggests that precision and digital farming topics remain peripheral within general farmer groups (Mulaudzi et al., 2024). This points to a need for deliberate content curation, structured integration of smart agriculture topics, and the involvement of trained moderators or extension agents to elevate the quality and focus of group discussions.

The strong association between participation intensity and smart agriculture adoption represents a central finding of this study. The pronounced stratification across participation frequency categories demonstrates that repeated exposure and peer reinforcement within trusted social networks accelerate progression through the innovation-decision process, from knowledge acquisition through persuasion to adoption. This pattern is particularly notable for knowledge-intensive practices such as weather-informed decision-making and micro-dosing, where farmers require ongoing information, reassurance, and peer validation before committing to behaviour change. These findings are consistent with evidence from other African countries, where sustained engagement in digital farmer groups predicted higher adoption of agricultural innovations (Mulaudzi et al., 2024; Fue et al., 2025).

The regression and ANOVA analyses revealed that participation frequency, information quality, and digital confidence are the primary mechanisms driving adoption. The finding that information quality explains a substantial share of variation in adoption confidence emphasises that credible, clear, and expert-validated content is essential for translating exposure into practical adoption (Abioye et al., 2024). Simply increasing participation volume without ensuring content quality is unlikely to yield meaningful adoption gains. Group structural characteristics and peer trust, while statistically significant, contributed smaller effects, suggesting they serve as enabling rather than primary conditions for adoption.

The barriers analysis reveals that infrastructural constraints remain the most formidable challenges to social media-mediated smart agriculture diffusion. Inconsistent internet connectivity, high data costs, and unreliable electricity supply collectively limit the frequency, duration, and quality of farmer engagement with digital platforms (Sharma et al., 2025; Choruma et al., 2024). These barriers disproportionately affect the poorest and most remote farmers, risking the creation of a digital divide within the smallholder sector. Complementing these infrastructural challenges, digital literacy gaps, misinformation, and inadequate smartphone functionality present human capital and technological barriers that requires urgent interventions. These results suggest that scaling smart agriculture through social media requires complementary investments in rural digital infrastructure, content moderation, digital literacy programmes, and institutional partnerships to enable sustainable and equitable adoption (Abate et al., 2023; Lwoga, 2010).

4.0. Conclusion

This study demonstrates that participation in WhatsApp and Facebook farmer groups significantly enhances the adoption of smart agriculture techniques among smallholder farmers in Oyo State. High-frequency participants adopted more than three times the number of smart practices compared to low-frequency participants, with adoption strongly influenced by repeated engagement, credible information, and digital competence. The results highlight that social media platforms serve as powerful channels for knowledge dissemination, peer learning, and decision support, particularly for cost-effective and knowledge-intensive innovations such as improved seed varieties, micro-dosing of fertilizers, and weather-informed decision-making. Group dynamics, including leadership quality and peer trust, further reinforce adoption by providing social validation and technical guidance, demonstrating that both structural and relational factors are critical in facilitating technology uptake. However, the study underscores persistent barriers that limit the full potential of digital adoption. Infrastructural constraints such as inconsistent internet connectivity, high data costs, and unreliable electricity, combined with digital literacy gaps, inadequate smartphone features, and misinformation, continue to impede widespread adoption of more advanced and capital-intensive smart agriculture practices.

5.0 Recommendation

Based on the findings of the study, it is therefore recommended that:

i. Government and the Nigerian Communications Commission (NCC), in partnership with major telecommunications providers (MTN Nigeria, Airtel, and Glo), should develop and implement subsidised or zero-rated mobile data packages specifically designed for accessing agricultural information through WhatsApp, Facebook, and digital advisory platforms.
ii. Agricultural Development Programmes (ADPs) and the National Agricultural Extension and Research Liaison Services (NAERLS) should formally incorporate existing WhatsApp and Facebook farmer groups into their extension outreach strategies. This should include training extension agents to serve as moderators and expert contributors within these groups, providing verified agronomic guidance and correcting misinformation. Local Government Agricultural Officers should be equipped with smartphones and data allowances to participate actively in farmer groups within their jurisdictions.
iii. The National Information Technology Development Agency (NITDA), in collaboration with the State Ministry of Education, farmer cooperatives (such as the All Farmers Association of Nigeria, AFAN), and international development agencies (e.g., GIZ, IFAD, FAO), should implement digital literacy training programmes for smallholder farmers. These programmes should produce smart agriculture content in local languages and Nigerian Pidgin with visual aids, video tutorials, voice notes, and simplified app interfaces.
iv. Farmer organizations and cooperatives in collaboration with the Agricultural Research Council of Nigeria (ARCN) should establish standards for group moderation, verified expert contributions, and misinformation management, while creating mechanisms to connect members with input suppliers, financial services, and markets, enabling groups to function as both knowledge-sharing and economic support hubs for smart agriculture adoption.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Perplexity AI for paraphrasing and reference formatting. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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