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Effectiveness of ICT-based extension services in disseminating agricultural information to farmers

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Abstract
Can Information and Communication Technology (ICT) bridge the gap between agricultural research institutions and farming communities in rural Nigeria? This research assessed the effectiveness of ICT-based extension services among 240 smallholder farmers in Bayelsa State, Niger Delta, using a cross-sectional survey from March to September 2023. Respondents were selected through stratified random sampling. A structured schedule measured awareness, access, and satisfaction with ICT tools including mobile advisories, community radio, and web kiosks. Results showed 68.3% of farmers had accessed at least one ICT channel in the preceding year. Mobile advisory services recorded the highest adoption (71.6%), followed by social media groups (42.8%). Farmers with secondary education were 2.7 times more likely to adopt ICT channels (OR = 2.74, $p<0.01$). Perceived relevance and ease of access emerged as the strongest predictors of continued use. ICT platforms improved information reach, though disparities linked to age, literacy, and infrastructure persist.

Keywords: ICT-based extension, agricultural information dissemination, smallholder farmers, mobile advisory services, technology adoption, knowledge gain, rural communication, digital agriculture

Introduction
How effectively do modern communication technologies reach farming communities that need them most? Agricultural extension has long been the main channel for transmitting research-generated knowledge to rural producers, yet conventional face-to-face delivery has struggled with coverage, timeliness, and cost [1]. In Nigeria's Niger Delta, where terrain and infrastructure limit agent mobility, only a fraction of farming households receive regular extension contact [2]. ICT tools mobile phones, radio, internet kiosks, and social media offer a way to bypass many of these barriers [3].

National programmes including e-Extension and the National Agricultural Technology Project have promoted ICT use in agriculture over the past decade [4]. Independent evaluations reported mixed outcomes: mobile-based advisories improved input use in parts of Oyo and Kaduna States [5], but adoption plateaued where digital literacy remained low [6]. Mittal and Tripathi [7] argued that perceived relevance and source trust predict sustained use more strongly than device ownership. Similarly, Aker [8] found voice-based services outperformed text messages among semi-literate populations. But few investigations have examined ICT extension in the Niger Delta region, where multiple language communities coexist and connectivity is uneven [9]. This research aimed to assess ICT-based extension effectiveness in Bayelsa State and identify factors influencing adoption and satisfaction.

Material and Methods
Research area
The research was conducted in Bayelsa State (4°15′-5°23′ N, 5°22′-6°45′ E), which experiences a tropical monsoon climate with average annual rainfall of 2,800 mm. Cassava, plantain, and vegetables dominate the cropping pattern. Extension coverage is handled by Agricultural Development Programmes, though agent-to-farmer ratios remain above 1:2,000 [2].

Material
Primary data were collected from March to September 2023 through face-to-face interviews with 240 farmers selected from four development blocks Yenagoa, Sagbama, Kolokuma,

and Ogbia through stratified random sampling based on landholding category. The pre-tested structured schedule gathered information on socio-economic characteristics, ICT access and use, extension contact history, and satisfaction. Reliability was confirmed through pilot testing (Cronbach's alpha = 0.83) on 30 non-sample respondents in Rivers State.

Methods

Effectiveness was measured through a 20-item knowledge test, an adoption index based on recommended practices followed, and a Likert-type satisfaction score across five dimensions. Data were analysed using SPSS v26 with descriptive statistics, chi-square tests, and binary logistic regression [10]. The dependent variable was dichotomous (adopted any ICT channel = 1, not adopted = 0). Ethical clearance was obtained from the Niger Delta Agricultural Institute Research Ethics Committee (Protocol No. NDAI/REC/2023-014, dated 12 February 2023).

Results

Sampled farmers ranged from 22 to 67 years (mean = 41.3 ± 10.8). About 56.7% had secondary education, and marginal holdings dominated (47.1%). Smartphone ownership stood at 61.3%, though only 43.8% reported regular internet access.

Table 1: Socio-economic profile of sampled farmers (N = 240)

Variable	Category	Frequency	Percentage
Age (years)	22-35	72	30.0
	36-50	108	45.0
	Above 50	60	25.0
Education	Primary	44	18.3
	Secondary	136	56.7
	≥ Higher sec.	60	25.0
Landholding	Marginal (< 1 ha)	113	47.1
	Small (1-2 ha)	81	33.8
	Medium (> 2 ha)	46	19.1

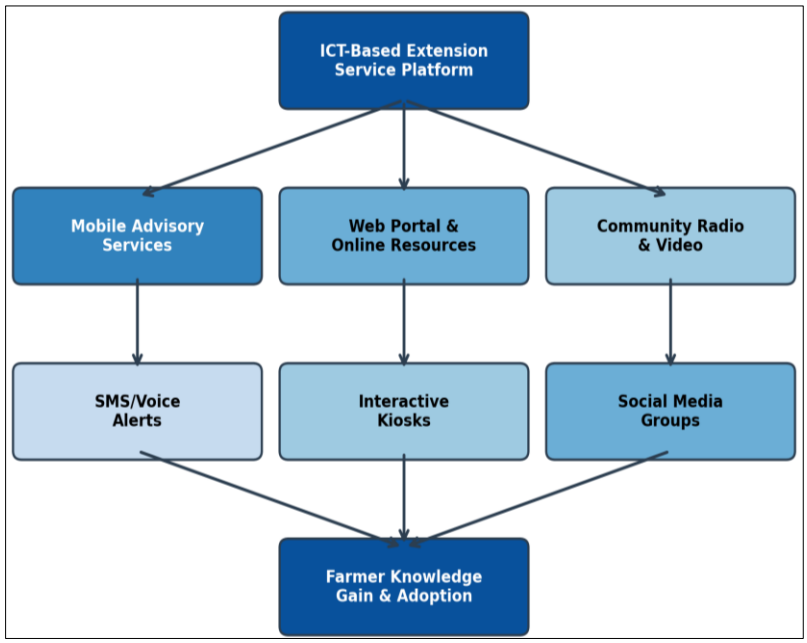

Fig 1: ICT-based extension service delivery model in the research area

The flowchart maps the delivery architecture through three tiers mobile advisory, web-based resources, and community media each cascading into specific tools reaching the farmer endpoint.

Table 2: Knowledge and adoption scores across ICT user categories

Category	N	Mean knowledge	SD	Adoption index	p-value
ICT adopters	164	14.6	2.83	0.72	
Non-adopters	76	9.2	3.17	0.48	
Overall	240	12.9	3.84	0.64	< 0.001

ICT adopters recorded a mean knowledge score of 14.6 out of 20, substantially higher than non-adopters (9.2, p<0.001). The adoption index mirrored this pattern (0.72 vs. 0.48)

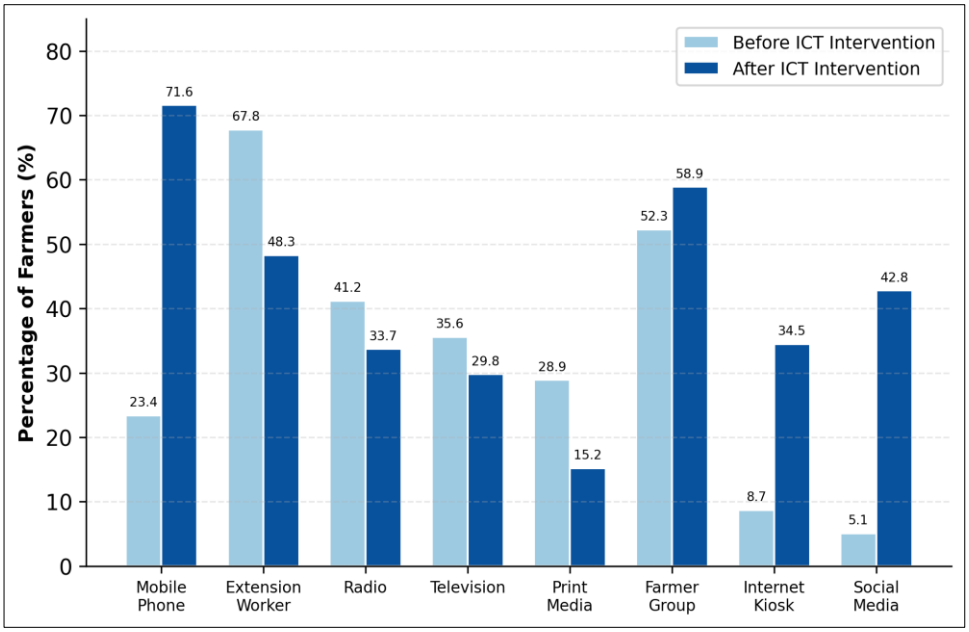

Fig 2: Information source use before and after ICT intervention (% of farmers)

Mobile phone use surged from 23.4% to 71.6%, while reliance on extension workers dropped from 67.8% to 48.3%. Social media groups saw the steepest relative increase, climbing from 5.1% to 42.8%.

Table 3: Logistic regression predictors of ICT adoption

Predictor	B	SE	Wald	OR	95% CI	p
Education (≥ sec.)	1.008	0.321	9.87	2.74	1.46-5.14	0.002
Smartphone	0.894	0.298	8.99	2.44	1.36-4.39	0.003
Age (years)	−0.034	0.015	5.13	0.97	0.94-0.99	0.024
Extension contact	0.612	0.264	5.37	1.84	1.10-3.09	0.021
Annual income	0.327	0.189	2.99	1.39	0.96-2.01	0.084

The model was significant ($\chi^2 = 48.6$, df = 6, $p<0.001$, Nagelkerke $R^2 = 0.31$). Education and smartphone ownership were the strongest predictors, while age had a small negative effect

Discussion

The finding that 68.3% of farmers used at least one ICT channel aligns with rising mobile-based information access across Sub-Saharan African farming communities reported by Aker and Mbiti [11]. Mobile advisories led at 71.6%, matching the pattern Mittal [5] observed in south-western Nigeria but exceeding the 54% adoption recorded in comparable south-southern states by Baruah and Das [9]. The higher figure here may reflect targeted SMS campaigns under the district's Digital Agriculture Mission during 2022-23.

Education emerged as the dominant predictor (OR = 2.74), echoing findings from Ghana [12] and Tanzania [13]. Literate farmers navigate text interfaces, interpret written advisories, and search for supplementary content independently. Yet the smartphone ownership variable (OR = 2.44) hints at a hardware barrier education alone cannot overcome. The negative age effect is also worth noting older farmers showed lower ICT engagement, possibly because they perceive the learning cost as exceeding marginal information gain [14]. Voice-first and vernacular interfaces could lower that barrier.

Limitations

The cross-sectional design captures a single time-point and cannot establish causality. Self-reported adoption data may involve recall bias, and the sample was restricted to four blocks, limiting generalisability. The research did not measure information quality received through ICT channels. Longitudinal designs tracking cohorts over multiple seasons would strengthen future conclusions.

Practical applications

Extension agencies in southern Nigeria may benefit from expanding vernacular voice-based mobile services for semi-literate and older populations and integrating facilitator-managed social media groups. High satisfaction scores for locally relevant, timely content reinforce that message quality drives sustained engagement [15]. State administrations could embed ICT modules into existing farmer training programmes to accelerate digital literacy.

Conclusion

This research set out to evaluate ICT-based extension effectiveness in Bayelsa State. ICT adopters scored 5.4 points higher on the knowledge test and showed a 50% higher adoption index compared with non-adopters. Mobile advisories and social media emerged as the fastest-growing channels, while conventional extension contacts declined in relative importance. Investment in ICT infrastructure and digital literacy yields measurable returns, but benefits are unevenly distributed younger, better-educated farmers with smartphone access gain the most. Future work should explore voice-based systems in local dialects and community-mediated digital hubs to narrow this divide [16].

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