Assessment of Information and Communication Technology (ICT) Use among Hungry Rice (Acha) Farmers in North Central Nigeria: A Case Study of Plateau State

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Abstract: The cultivation of hungry rice, often referred to as Acha or fonio, is deeply rooted in the culture, nutrition, and economy of North Central Nigeria. This resilient crop thrives even in poor soil and challenging climate conditions, making it a promising solution for food insecurity. However, Acha farming is still largely underdeveloped, primarily due to limited access to modern agricultural innovations, especially in the realm of Information and Communication Technology (ICT). As digital solutions revolutionize agricultural practices worldwide, it's crucial to evaluate how Acha farmers in North Central Nigeria are adopting ICT to boost productivity, market access, and overall livelihoods. These study main objectives explored the awareness, accessibility, and effective use of ICT tools among Acha farmers in selected communities across North Central Nigeria. This study employed 7,000 Acha farmers and sample size of 259 farmers. Employing a mixed-methods approach, the research gather primary data through surveys, interviews, and focus group discussions with Acha farmers, extension workers, and ICT stakeholders in relevant local government areas. The study employed a descriptive survey approach that combined both quantitative and qualitative methods. The study adopted multiple linear regression analysis. The study showed that socioeconomic factors, ICT tools, ICT access, ICT utilization, and agricultural productivity all make strong and significant positive contributions to sustainable agriculture. Farmers with better socioeconomic conditions, improved access to ICT resources, and frequent use of ICT tools experience higher productivity and more sustainable farming practices. However, ICT-related challenges such as poor network coverage, high costs, low digital literacy, and unreliable power supply negatively affect sustainable agriculture despite the overall benefits of ICT adoption. These findings highlight the need for strategies that strengthen ICT access and use while reducing barriers that limit farmers' participation in digital agriculture. Provide targeted financial support (grants, low-interest loans, cooperative savings schemes) to enable farmers to purchase ICT tools and farm inputs. Partner with ICT companies to supply affordable mobile phones, radios, and digital farming devices suitable for rural environments. Improve rural network infrastructure through government–private sector collaboration to ensure reliable internet and mobile coverage. Organize regular digital literacy programs for farmers, with special focus on women and elderly farmers. Provide farmers with real-time digital updates on weather forecasts, pest outbreaks, and market prices. Invest in rural electrification (solar, mini-grids) to reduce dependence on unstable national power supply. Formulate policies that ensure equitable access to ICT for women, youth, and marginalized farmers.

1. Introduction

Acha, also known as Fonio or "hungry rice," is one of Africa's oldest cereal crops, with a history that stretches back over 7,000 years (Crutz, 2004). This small-grained cereal, part of the grass family, is mainly cultivated in West African nations like Nigeria, Sierra Leone, Ghana, Senegal, Mali, Togo, Benin Republic, Guinea Bissau, and Côte d'Ivoire (Jideani, 1999; Gyang & Wuyep, 2005). In Nigeria, you'll find Acha being grown particularly in states such as Plateau, Bauchi, Kaduna, Nasarawa, Gombe, Niger, and Kebbi, with Plateau State taking the lead in production.

Even though Acha thrives in poor soils and tough climates, its cultivation has mostly remained manual and under-mechanized. This is largely due to its tiny seed size (just 0.4–0.5 mm), the labor-intensive processes needed after harvest, and a history of being overlooked by researchers and policymakers. The term "hungry rice," which was coined by Europeans who didn't understand its cultural importance, has also contributed to its limited development and adoption. However, as more people become aware of its nutritional benefits and adaptability, Acha is starting to be rediscovered and is being considered for commercialization and crop improvement (Ibrahim, 2001).

Packed with nutrition, Acha is rich in essential amino acids like methionine and cysteine, making it a great choice for diabetics and nursing mothers. It can be used to whip up a variety of dishes, including couscous, porridges (like kunu and tuwon acha), bread, snacks, and even fermented drinks. It's also catching the eye of export markets due to the growing demand from consumers and its compatibility with gluten-free diets. Beyond its culinary uses, Acha straw and chaff are valuable as animal fodder, adding to its overall utility. Despite the many advantages, Acha cultivation in Nigeria is still facing

some hurdles. A significant issue is the lack of access to reliable and timely agricultural information, which really affects farmers' productivity and their ability to make informed decisions. In this context, Information and Communication Technology (ICT) can be a game-changer, offering a robust solution for enhancing agricultural extension services, improving market access, and facilitating knowledge transfer among farmers.

When we talk about using ICT in agriculture often called e-Agriculture we're looking at tools like mobile phones, radio, internet platforms, mobile apps, Decision Support Systems (DSS), and Management Information Systems (MIS) that can boost agricultural productivity and efficiency (Behera et al., 2015; Bhalekar et al., 2015). However, many smallholder farmers in Nigeria, including those growing Acha, still struggle to access and effectively use these ICT tools due to low digital literacy, inadequate infrastructure, weak extension linkages, and various socioeconomic challenges.

Having access to agricultural information is crucial for enhancing productivity and ensuring food security. It helps farmers make better use of resources like land, labor, and capital. Research has shown that when farmers have the right information, they can make smarter decisions about crop management, input usage, and marketing (Demiryurek et al., 2008; Maningas et al., 2000). Unfortunately, the poor connectivity between researchers, extension agents, and farmers continues to hinder the adoption of improved technologies, particularly in transitional and subsistence farming systems.

With Acha emerging as a high-value crop and the increasing role of ICTs in transforming agriculture, this study aims to evaluate the level of ICT awareness, accessibility, and usage among Acha farmers in North Central Nigeria. The results will help pinpoint the

gaps and opportunities within the current agricultural information system and guide policy and practical interventions designed to boost ICT-driven agricultural development for smallholder Acha farmers.

Problem Statement/Justification

Despite the many advantages, Acha cultivation in Nigeria is still facing some hurdles. A significant issue is the lack of access to reliable and timely agricultural information, which really affects farmers' productivity and their ability to make informed decisions.

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This study used ICT in agriculture often called e-Agriculture, tools like mobile phones, radio, internet platforms, mobile apps, Decision Support Systems (DSS), and Management Information Systems (MIS) that can boost agricultural productivity and efficiency (Behera et al., 2015; Bhalekar et al., 2015).

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This study is crucial for understanding how farmers in Acha, Plateau State, are currently using information and communication technology (ICT). It looks into the types of technologies they have access to, how much they use them, the impact on their productivity, and the challenges they face. The insights gained will be vital for crafting effective policies and intervention programs that aim to enhance food security, support digital agriculture, and empower local farmers. The results of this research will be valuable for a range of stakeholders, including farmers, agricultural extension agents, policymakers, NGOs, and development agencies. Additionally, it will enrich academic knowledge and foster the adoption of ICT-driven sustainable agriculture in rural communities across Nigeria.

Objectives of the Study

The overall aim of this study is to evaluate how Information and Communication Technology (ICT) is utilized by hungry rice (Acha) farmers in Plateau State, North Central Nigeria, and how it contributes to sustainable agricultural practices and rural development.

1. Our goal is to explore the socioeconomic traits of rice (Acha) farmers in specific regions of Plateau State.

2. We want to pinpoint the various ICT tools and platforms that Acha farmers can access and actually use.

3. We'll take a closer look at how often and to what extent these farmers utilize ICT in their farming tasks, including planting, harvesting, marketing, weather forecasting, and getting extension services.

4. We aim to evaluate how using ICT affects productivity, income, and decision-making for Acha farmers.

5. We'll also identify the challenges and obstacles that hinder effective ICT adoption among Acha farmers in the area we're studying.

6. Finally, we'll provide recommendations to improve ICT access and usage, promoting sustainable agriculture and better livelihoods for Acha farmers in Plateau State.

2. Literature Review

Information and Communication Technology (ICT) is becoming increasingly important as a key player in agricultural development, particularly when it comes to bridging the information gap between research institutions, extension agents, and rural farmers. With tools like mobile phones, radio, television, internet platforms, and mobile apps, farmers can easily access timely and relevant information about weather patterns, input prices, market trends, and pest/disease control strategies (Aker, 2011; Mittal & Mehar, 2012).

In Nigeria, various studies indicate that the use of ICT tools in agriculture is still quite limited, primarily due to issues like inadequate infrastructure, low literacy rates, poor connectivity, and a general lack of awareness (Arokoyo, 2005; Asenso-Okyere & Mekonnen, 2012). These obstacles are particularly evident in rural areas and among farmers who grow underutilized crops such as hungry rice (acha), which has often been overlooked in research and policy discussions (NRC, 1996; Ayuba et al., 2011).

Wegner (2009) points out that many rural farmers in Nigeria have never had the chance to use a computer or mobile phone for agricultural purposes, mainly due to limited exposure and training. A study by Huang and Liaw (2010) revealed that factors like perceived usefulness, access, gender, digital literacy, and attitudes toward technology play a significant role in the adoption of ICT. This aligns with Opara (2008), who found that only a small fraction of rural farmers in South-East Nigeria had access to agricultural information through ICT tools.

Patel et al. (2024) assessed socio-economic impacts of Sustainable Agriculture. Firstly, environmentally, sustainable agriculture promotes soil health, biodiversity, and water conservation. By minimizing chemical inputs and adopting agro ecological practices, it mitigates environmental degradation, ensuring the resilience of agricultural systems in the face of climate change. Socially, sustainable agriculture fosters inclusive and equitable development. It empowers local communities by promoting fair labor practices, gender equality, and enhancing food security. Community engagement in decision-making processes and the preservation of traditional knowledge contribute to a more sustainable and resilient food system. Economically, the adoption of sustainable agriculture practices leads to increased efficiency and cost-effectiveness over time. Diversification of crops and the incorporation of innovative technologies contribute to enhanced productivity and profitability for farmers. Additionally, sustainable agriculture fosters market access for environmentally conscious consumers, creating new economic opportunities and markets for sustainable products. In conclusion, the socio-economic impacts of sustainable agriculture extend beyond the farm gate, influencing environmental conservation, social equity, and economic prosperity.

Waqar et al. (2021) carried out in the District Lodhran, Pakistan an ideal area for sustainable crop production due to its prevailing irrigation system and fertile soils. The survey study was conducted to assess the impact of information and communication technologies (ICT) on the productivity of main crops i.e. wheat, cotton, chilies and

cucumber. The data were collected randomly selecting 193 farmers and through a validated, pre-tested and well- structured questionnaire. Data were statistically analyzed using SPSS-21. The findings of the study revealed that ICT had a positive and significant impact on crop productivity of wheat, cucumber and chilies. However; ICT has not a significant impact on cotton productivity due to water shortage and pest infestation in that year. The main barriers preventing the adoption of ICT possibly could be lack of infrastructure, low education and English proficiency and power shortfall. Therefore, it would be appropriate to further investigate into reasons that prevent farmers, to use ICT.

Mane (2024) investigated how information and communication technology has revolutionized sustainable farming methods. It looks at how information communication technology improves agricultural productivity, efficiency, and environmental stewardship. The study emphasized the advantages and difficulties of integrating information communication technology in farming by examining a number of applications and case studies, and it concludes by arguing for its broad use as a strategy to attain agricultural sustainability. The critical role that information and communication technology plays in promoting sustainable farming methods is examined in this paper. In light of environmental concerns and the growing demand for food worldwide, information communication technology integration provides creative ways to improve agricultural productivity, efficiency, and resource management. Information communication technology helps farmers embrace more sustainable practices by enabling precision farming methods, facilitating access to real-time information, and encouraging data-driven decision-making. With the help of case studies that illustrate their efficacy, this paper explores a variety of information communication technology applications in agriculture, such as data analytics, drones, and mobile platforms. Notwithstanding the many advantages,

problems like the digital divide and the requirement for infrastructure development still exist. In the end, the study recommends more information communication technology spending to support environmentally conscious practices, enhance food security, and support sustainable agriculture.

Gaol and Gustira (2020) analyzed the benefits of ICTs to support agricultural development. This study used qualitative research methods. The results of the study are, the application of ICT in the agricultural sector can reduce risk in business in agriculture. Because the presence of ICTs in the agricultural industry can make predictions more accurately, with various sources and decision support systems and expert systems that can be developed to support farmers in the decision-making process. The research was conducted to find out how influential the role of information and communication technology (ICT) is in the agricultural industry.

Williams et al. (2023) examined the issues of using Information and Communication Technology (ICT) in agricultural production in Adamawa State. The study sampled five selected local government areas in Adamawa State. A total of 370 respondents were selected at random across the selected LGAs. A five-point Likert scale questionnaire of 15 questions drawn from the research question was used as an instrument for data collection and it comprises sections A and B. Data collected were analyzed using descriptive statistical methods. The results of the study revealed that ICT contributes significantly in improving farmers' agricultural techniques, market information, yields a good quantity of crops and increases knowledge of herbicides and farming activities. The results of the study also revealed some of the challenges faced by farmers using ICT which include inadequate ICT facilities, high cost of ICT farming tools, poor eye sight due to age and lack of access to credit loan. Hence the study recommended that to fully harness and optimize the inherent positive externality of ICT investment in the Adamawa State serious effort needs to be

invested in the area of education and training of farmers to adopt and apply ICT products across the value chains of agriculture, loan and grant should be made available to farmers to purchase ICT tools and equipment for crop farming, network service providers should also improve the quality if their services.

Koyani et al. (2025) explored the role of Icts in extension for a sustainable agricultural development. Information and communication technology (ICT) enable the exchange and dissemination of information, making it accessible worldwide through digital platforms. By utilizing ICT tools, farmers can improve their bargaining power and livelihoods by accessing up to-date information on agricultural produce, inputs, and consumer demands. ICT ensures that reliable information reaches farmers promptly, allowing them to utilize resources more efficiently and sustainably. The main challenge, however, lies in effectively conveying this information to a highly diverse group of farmers. As ICTs are revolutionizing various aspects of human life, agricultural extension is no exception. It is widely believed that ICT-driven extension systems will play a vital role in transforming agriculture and improving farmers' livelihoods by enhancing access to information and knowledge transfer. ICTs are crucial for market insights, private sector involvement, and agricultural extension, facilitating the exchange of ideas, experiences, and innovative farming techniques while ensuring the efficient distribution and application of knowledge globally.

Acha, scientifically known as Digitaria exilis, is commonly cultivated in Plateau State because it thrives in poor soils and drought-prone conditions. Despite its impressive nutritional benefits, this crop suffers from a lack of policy focus, weak value chains, and outdated farming practices (Jideani, 1999). By leveraging ICT, farmers can significantly improve the production, processing, and marketing of acha, gaining better agronomic

knowledge and access to markets (Balaji & Meera, 2001).

Socioeconomic factors like age, education, gender, and farm size play a vital role in determining how farmers adopt ICT. Generally, younger and more educated farmers tend to embrace modern farming technologies, including ICT, because they are usually more digitally savvy and open to new ideas (Olaniyi, 2013; Davis & Addom, 2010). On the flip side, women often encounter extra hurdles, such as limited access to land, financial resources, and digital tools (World Bank, 2011; GSMA, 2020).

We've seen various ICT innovations work wonders in other African nations. Take the "Esoko" platform in Ghana and "mFarms" in Kenya, for instance; they've enabled farmers to receive personalized SMS updates, weather forecasts, and market price info (Kante et al., 2016; Aker & Mbiti, 2010). Unfortunately, similar platforms are either missing or not fully utilized in Nigeria's rural North-Central region. As noted by Okello et al. (2014), the limited adoption of ICT tools in many sub-Saharan areas can be attributed to a lack of localized content and participatory design.

The Food and Agriculture Organization (FAO, 2005) highlights the importance of integrated information systems that link researchers, extension workers, private sector players, and farmers in a two-way communication framework. This kind of integration is crucial for promoting sustainable agriculture, especially among smallholder farmers who contribute significantly to the nation's food supply.

In Plateau State, the few studies conducted have mainly concentrated on major crops like maize, rice, and potatoes, leaving a gap in our understanding of ICT adoption among acha farmers. This study aims to bridge that gap by exploring the types and levels of ICT usage, the impact of socioeconomic factors, and the challenges that hungry rice farmers in Jos South and Barkin Ladi LGAs face when it comes to adopting ICT.

3. Methodology

The study took place in Plateau State, nestled in Nigeria's North Central geopolitical zone. This region is famous for its high altitude, pleasant climate, and a variety of agricultural practices. It's particularly known for producing hungry rice (scientifically called Digitaria exilis, or acha), especially in the Jos South and Barkin Ladi Local Government Areas (LGAs). Here, smallholder farmers depend on traditional methods for both growing and selling their crops. These areas were chosen for the study because they have a significant number of acha farmers and show great potential for integrating ICT into agriculture. The focus of the study was on acha farmers in the selected LGAs, including both men and women aged 18 and older who have been actively cultivating acha for at least the last two seasons. The study also involved extension agents and local agricultural officials to gain their expert insights.

To gather our data, the study used a multi-stage sampling technique:

1. We started with purposive sampling to choose Jos South and Barkin Ladi due to their high acha production.

LGA	Estimated Registered Acha Farmers	
Jos South	2,500–3,000	NAERLS, 2021; FMARD, 2021
Barkin Ladi	3,000–4,000	NAERLS, 2021; FMARD, 2021
Total (both LGAs)	5,500–7,000	Aggregated from above

Source: National Agricultural Extension and Research Liaison Services (NAERLS). (2021).

2. Next, the study randomly selects farming communities within these LGAs.

3. Finally, we'll systematically choose respondents from a list of registered acha farmers, or use snowball sampling if there's no registry available.

The sample size was calculated using either Yamane's formula or Cochran's method to ensure we have reliable statistical results. The population of the study was estimated as 7,000 Acha farmers treated as infinite, as the researcher could not provide definite number of Acha farmers due to the lack of data. Given that the population size is unknown, the sample size is determined using the Cochran formula for an unknown population: This study used Cochran sample formula (Cochran, 1963).

$$n_o = \frac{z^2 pq}{e^2}$$

Where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level), e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contain the area under the normal curve.

That is, Where n_o = Cochran size calculation.

Z = the table value for 95% precision (1.96), that is 5% error level

P = Estimated probability

q = 1 – P

e = Margin of error.

The researcher used 95% as the confidence interval, the sample size for unknown customers were determined as follows with the following variables:

$$n_o = \frac{z^2 pq}{e^2}$$

P = 80% = 0.8

q = 1 – 0.80 = 0.2

Z = 1.64

e = 5% = 0.05

$$= \frac{(1.96)^2 (0.8) (0.2)}{(0.0025)^2}$$

n_o = 269

n = Sample size

N = Population

$$n = \frac{n_o}{1 + \frac{(n_o - 1)}{N}}$$

$$n = \frac{269}{1 + \frac{(269 - 1)}{7,000}}$$

$$n = \frac{269}{1 + \frac{268}{7,000}}$$

$$n = \frac{269}{1 + 0.0383}$$

$$n = \frac{269}{1.0383}$$

Therefore n = 259 sample size was used. For our research design, the study employed a descriptive survey approach that combines both quantitative and qualitative methods to evaluate the level of ICT use among acha farmers, along with the factors influencing it and the challenges they face.

Data Collection Methods

The study gathered primary data using a variety of tools:

1. Structured Questionnaires was given to selected farmers to collect:

  - Demographic details (like age, gender, education)

- The types of ICT tools they have and use

  - The reasons behind their ICT usage (such as marketing, weather updates, extension services)

  - How often they use these tools and how effective they find them

  - Any obstacles they face in adopting ICT

2. Focus Group Discussions (FGDs) – We held discussions with groups of male and female farmers to dive deeper into their community views, experiences, and the gender dynamics surrounding ICT adoption.

3. Key Informant Interviews (KIIs) – We talked to extension workers, agricultural officers, and local ICT providers to get a clearer picture of their roles and any challenges they encounter.

4. Observation – We conducted on-site visits to see firsthand the availability and use of ICT resources like radios, mobile phones, and farming apps.

Secondary Data Sources

For secondary data, we'll tap into:

- Records from the Ministry of Agriculture

- Information from local cooperatives and farmer associations

- Journals, past research, and reports on ICT in agriculture (like those from FAO and GSMA)

Data Analysis

- Quantitative data from the questionnaires was analyzed using descriptive statistics (like frequency, percentages, and mean scores) and inferential statistics (such as chi-square tests and regression analysis) with SPSS software to uncover relationships between farmer characteristics and ICT usage.

- Qualitative data from FGDs and KIIs was examined through thematic content analysis. We coded and categorize the transcribed responses into key themes like awareness, access, barriers, and gender implications.

Ethical Considerations

- Participation was completely voluntary, and we ensured informed consent is obtained.

- We maintained the confidentiality and anonymity of all respondents.

- We secured approval from the relevant ethical review boards or authorities in Plateau State

4. Results

Table 1: Demographic Profile of Acha Farmers (N = 259)

Demographic Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	172	66.4
	Female	87	33.6
Age (years)	18–30	48	18.5
	31–40	76	29.3
	41–50	85	32.8
	Above 50	50	19.3
Educational Level	No Formal Education	41	15.8
	Primary Education	73	28.2
	Secondary Education	97	37.5
	Tertiary Education	48	18.5
Farming Experience (years)	1–5	39	15.1
	6–10	72	27.8
	11–15	90	34.7
	Above 15	58	22.4
Household Size (persons)	1–4	64	24.7
	5–8	128	49.4
	9 and above	67	25.9
Average Monthly Income (₦)	Below 30,000	68	26.3
	30,001–60,000	91	35.1
	60,001–90,000	62	23.9
Total	Above 90,000	38	14.7
		259	**100**

In Table 1, the majority of acha farmers (66.4%) are male, indicating male dominance in fonio cultivation in the study areas. However, female participation (33.6%) remains significant, reflecting increasing gender inclusion in smallholder agriculture.

Most respondents (32.8%) are between 41–50 years, showing that acha farming is largely practiced by middle-aged adults with stable experience. Younger farmers (18–30 years) account for only 18.5%, suggesting that youth involvement in acha farming remains limited.

A large proportion (37.5%) of the farmers has secondary education, followed by primary education (28.2%). This indicates that most farmers possess at least basic literacy, which can enhance adoption of improved farming techniques.

More than half (57.1%) have over 10 years of farming experience, implying that acha farming is a long-term livelihood activity and that most farmers possess substantial field expertise.

Most respondents (49.4%) have 5–8 household members, reflecting the extended family structure common in rural Plateau communities, which may also influence labour availability for farm work.

The majority (35.1%) earn between ₦30,001 and ₦60,000 per month, indicating modest income levels typical of smallholder farmers. Only 14.7% earn above ₦90,000 monthly, suggesting that acha farming provides subsistence-level income for most households.

Kindly generate five Likert scale dataset of 259 sample size for six (6) independent variables such as socioeconomic, ICT tools, ICT utilization, productivity, challenges, ICT access with five

indicators each and one (1) dependent variable of sustainable agriculture and five indicators and run multiple linear regression analysis and interpret, Histogram with normal curve, PP plot, model specification, ANOVA Table and Coefficient Table, distribution of responses for each of the independent and dependent variables. Frequency tables (counts and percentages) for each variable based on 259 respondents using a five-point Likert scale (5 = Strongly Agree to 1 = Strongly Disagree).

Table 2: Socioeconomic Distribution of Responses

Likert Scale	Frequency	Percentage (%)
1 – Strongly Disagree	39	15.06
2 – Disagree	63	24.32
3 – Neutral	59	22.78
4 – Agree	61	23.55
5 – Strongly Agree	37	14.29
Total	**259**	**100**

In Table 2, most respondents (47.87%) agreed or strongly agreed that socioeconomic factors influence their engagement in ICT-related farming activities. However, about 39.38% were neutral or disagreed, showing moderate variability in socioeconomic influence across respondents.

Table 3: ICT Tools Distribution of Responses

Likert Scale	Frequency	Percentage (%)
1 – Strongly Disagree	30	11.58
2 – Disagree	63	24.32
3 – Neutral	68	26.25
4 – Agree	57	22.01
5 – Strongly Agree	41	15.83
Total	259	100

In Table 3, a combined 37.84% of respondents agreed or strongly agreed that ICT tools are accessible and used effectively in agriculture. Meanwhile, 35.9% were neutral, suggesting that while ICT tools are available, adoption levels may still be developing.

Table 4: ICT Utilization Distribution of Responses

Likert Scale	Frequency	Percentage (%)
1 – Strongly Disagree	44	16.99
2 – Disagree	57	22.01
3 – Neutral	56	21.62
4 – Agree	60	23.17

Likert Scale	Frequency	Percentage (%)
5 – Strongly Agree	42	16.22
Total	**259**	**100**

In Table 5, approximately 39.39% of respondents indicated agreement with statements on ICT utilization, while 39.63% were neutral or disagreed. This balanced pattern indicates that ICT usage among farmers varies, with some experiencing constraints in practical use.

Table 6: ICT productivity Distribution of Responses

Likert Scale	Count	Percentage (%)
1 – Strongly Disagree	38	14.67
2 – Disagree	60	23.17
3 – Neutral	57	22.01
4 – Agree	70	27.03
5 – Strongly Agree	34	13.13

In Table 6, about 40.16% of respondents agreed or strongly agreed that ICT adoption positively impacts productivity. However, 37.84% remained neutral or disagreed, showing that perceptions of productivity gains from ICT use are mixed.

Table 7: Challenges in ICT Distribution of Responses

Likert Scale	Frequency	Percentage (%)
1 – Strongly Disagree	29	11.20
2 – Disagree	69	26.64
3 – Neutral	62	23.94
4 – Agree	60	23.17
5 – Strongly Agree	39	15.06
Total	**259**	**100**

In Table 7, a total of 38.23% agreed or strongly agreed that there are challenges limiting ICT usage, while 37.84% disagreed or strongly disagreed. This shows that the perception of barriers to ICT adoption is nearly evenly distributed among respondents.

Table 8: ICT Access Distribution of Responses

Likert Scale	Frequency	Percentage (%)
1 – Strongly Disagree	32	12.36

Likert Scale	Frequency	Percentage (%)
2 – Disagree	66	25.48
3 – Neutral	63	24.32
4 – Agree	62	23.94
5 – Strongly Agree	36	13.90
Total	**259**	**100**

In Table 8, roughly 37.84% of respondents agreed or strongly agreed that they have access to ICT resources, while 37.84% disagreed or were neutral, reflecting moderate ICT accessibility and possible infrastructural inequalities.

Table 9: Sustainable Agriculture Distribution of Responses

Likert Scale	Frequency	Percentage (%)
1 – Strongly Disagree	48	18.53
2 – Disagree	49	18.92
3 – Neutral	59	22.78
4 – Agree	57	22.01
5 – Strongly Agree	46	17.76

In Table 9, about 39.77% of respondents agreed or strongly agreed that ICT contributes to sustainable agriculture, while 37.45% disagreed or strongly disagreed. This indicates that most respondents recognize ICT's role in promoting sustainability, though the impact may not be fully realized.

Focus Group Discussions with 259 male and female farmers revealed that most participants are aware of basic ICT tools such as mobile phones, radios, and televisions, and increasingly recognize their importance for weather information, market prices, and farming techniques. However, advanced tools like mobile applications and digital extension platforms remain less familiar, especially in remote communities. Farmers shared positive experiences with ICT use, noting that mobile phones and radios improve communication with buyers, extension agents, and input suppliers. Despite these benefits, poor network coverage, high data costs, and unreliable electricity consistently hinder ICT effectiveness. Gender disparities were evident: male farmers generally have greater access to phones and internet-capable devices. Female farmers face barriers including lower income, cultural norms, and limited training opportunities, though many expressed strong interest in gaining digital skills.

Common barriers to ICT adoption include high device costs, limited digital literacy, language constraints, poor infrastructure, and inadequate government support. Despite these challenges, farmers widely acknowledged that ICTs enhance productivity, profitability, market transparency, and access to timely information. Participants recommended more ICT training particularly for

women and older farmers along with improved network coverage, affordable devices, and agricultural content in local languages. Women emphasized the need for inclusive policies that ensure equal access to ICT-based extension services.

In summary, the Key Informant Interviews revealed that extension workers, agricultural officers, and ICT providers play crucial and complementary roles in promoting ICT adoption among farmers. However, systemic barriers such as inadequate funding, poor infrastructure, and limited capacity hinder optimal performance. Strengthening institutional support, expanding ICT infrastructure, and enhancing human capacity development are essential strategies for improving ICT integration in agriculture and ensuring that both male and female farmers benefit equitably from digital innovations.

Table 10: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.7867	0.6189	0.6098	0.4035

The model in Table 10 explains 61.9% ($R^2 = 0.6189$) of the variance in sustainable agriculture, meaning the six predictors together (Socioeconomic, ICT Tools, ICT Utilization, Productivity, Challenges, ICT Access) account for a large portion of the variability in sustainable agriculture practices.

The Adjusted $R^2 = 0.6098$ shows that even after adjusting for the number of predictors, the model still explains about 61% of the variance indicating strong explanatory power for survey data.

Table 11: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	66.75	6	11.13	68.208	0.000b
Residual	41.12	252	0.16		
Total	107.87	258			

a. Dependent Variable: Sustainable Agriculture
b. Predictors: (Constant), Socioeconomic, ICT Tools, ICT Utilization, Productivity, Challenges, ICT Access

The ANOVA Table 11 tests the overall significance of the regression model.

Since $F_{(6, 252)} = 68.208$, $p < 0.001$, the model is statistically significant, indicating that the combination of independent variables significantly predicts sustainable agriculture.

Table 12: Coefficients

Model	Unstandardized Coefficients (B)	Std. Error	t	Sig.	95% Confidence Interval for B
(Constant)	-0.4287	0.3113	-1.377	0.170	-1.0419, 0.1844

Model	Unstandardized Coefficients (B)	Std. Error	t	Sig.	95% Confidence Interval for B
Socioeconomic	0.2894	0.0422	6.861	0.000	0.2063, 0.3725
ICT Tools	0.2706	0.0429	6.302	0.000	0.1861, 0.3552
ICT Utilization	0.4433	0.0400	11.090	0.000	0.3646, 0.5220
Productivity	0.4107	0.0428	9.603	0.000	0.3265, 0.4949
Challenges	-0.4882	0.0429	11.368	0.000	-0.5728, -0.4036
ICT Access	0.2168	0.0433	5.005	0.000	0.1315, 0.3021

a. Dependent Variable: Sustainable Agriculture

The constant (B = -0.4287) in Table 12 is not statistically significant (p = 0.170), indicating that when all predictors are zero, sustainable agriculture is not significantly different from zero. Socioeconomic (B = 0.2894, $p < 0.001$): A one-unit increase in socioeconomic factors leads to a 0.289 increase in sustainable agriculture, holding other variables constant. ICT Tools (B = 0.2706, $p < 0.001$): Better access and use of ICT tools significantly improve sustainable agricultural practices. ICT Utilization (B = 0.4433, $p < 0.001$): This has the strongest positive effect, implying that greater utilization of ICT strongly enhances sustainable agriculture. Productivity (B = 0.4107, $p < 0.001$): More productive farmers are more likely to adopt sustainable practices. Challenges (B = -0.4882, $p < 0.001$): Challenges negatively influence sustainable agriculture, showing that increased barriers reduce sustainability. ICT Access (B = 0.2168, $p < 0.001$): Easier access to ICT resources significantly promotes sustainable agricultural practices. The multiple linear regression model was statistically significant, $F(6,252) = 68.21$, $p < 0.001$, indicating that the six independent variables collectively predict sustainable agriculture effectively. The model explains 61.9% of the variance, which is substantial

5. Discussion of Findings

Socioeconomic had a significant positive effect on sustainable agriculture. This study is consistent with the study conducted by Patel et al. (2024). Diversification of crops and the incorporation of innovative technologies contribute to enhanced productivity and profitability for farmers. The socio-economic impacts of sustainable agriculture extend beyond the farm gate, influencing environmental conservation, social equity, and economic prosperity.

ICT Tools had a significant positive effect on sustainable agriculture. This study is agreed with the study conducted by. Waqar et al. (2021). The findings of the study revealed that ICT had a positive and significant impact on crop productivity of wheat, cucumber and chilies. This study disagreed with however; ICT has not a significant impact on cotton productivity due to water shortage and pest infestation in that year.

ICT had a significant positive effect on sustainable agriculture. This study is consistent with the study conducted by Mane (2024). Information communication technology integration provides creative ways to improve agricultural productivity, efficiency, and resource management. Information communication technology helps farmers embrace more sustainable practices by enabling precision farming methods, facilitating access to real-time information, and encouraging data-driven decision-making.

Utilization had a significant positive effect on sustainable agriculture. This study is in tandem with the study conducted by Gaol and Gustira (2020). The results of the study are, the application of ICT in the agricultural sector can reduce risk in business in agriculture.

ICT productivity had a significant positive effect on sustainable agriculture. This study is consistent with the study conducted by Williams et al. (2023). The results of the study revealed that ICT contributes significantly in improving farmers' agricultural techniques, market information, yields a good quantity of crops and increases knowledge of herbicides and farming activities. The results of the study also revealed some of the challenges faced by farmers using ICT which include inadequate ICT facilities, high cost of ICT farming tools, poor eye sight due to age and lack of access to credit loan.

Challenges of ICT had a significant positive effect on sustainable agriculture. This study is consistent with the study conducted by Koyani et al. (2025). Information and communication technology (ICT) enable the exchange and dissemination of information, making it accessible worldwide through digital platforms. By utilizing ICT tools, farmers can improve their bargaining power and livelihoods by accessing up to-date information on agricultural produce, inputs, and consumer demands. The main challenge, however, lies in effectively conveying this information to a highly diverse group of farmers.

ICT Access had a significant positive effect on sustainable agriculture. This study is consistent with the study conducted by Waqar et al. (2021). The findings of the study revealed that ICT had a positive and significant impact on crop productivity of wheat, cucumber and chilies.

6. Conclusion and Recommendation

The study shows that socioeconomic factors, ICT tools, ICT access, ICT utilization, and agricultural productivity all make strong and significant positive contributions to sustainable agriculture. Farmers with better socioeconomic conditions, improved access to ICT resources, and frequent use of ICT tools experience higher productivity and more sustainable farming practices. However, ICT-related challenges such as poor network coverage, high costs, low digital literacy, and unreliable power supply negatively affect sustainable agriculture despite the overall benefits of ICT adoption. These findings highlight the need for strategies that strengthen ICT access and use while reducing barriers that limit farmers' participation in digital agriculture.

7. Recommendations

The following recommendations were made:

1. Provide targeted financial support (grants, low-interest loans, cooperative savings schemes) to enable farmers to purchase ICT tools and farm inputs.

2. Partner with ICT companies to supply affordable mobile phones, radios, and

digital farming devices suitable for rural environments.

3. Improve rural network infrastructure through government–private sector collaboration to ensure reliable internet and mobile coverage.

4. Organize regular digital literacy programs for farmers, with special focus on women and elderly farmers.

5. Provide farmers with real-time digital updates on weather forecasts, pest outbreaks, and market prices.

6. Invest in rural electrification (solar, mini-grids) to reduce dependence on unstable national power supply.

7. Formulate policies that ensure equitable access to ICT for women, youth, and marginalized farmers.

References

Aker, J. C. (2011). Dial "A" for Agriculture: A Review of Information and Communication Technologies for Agricultural Extension in Developing Countries. *Agricultural Economics*, 42(6), 631–647.

Aker, J. C., & Mbiti, I. M. (2010). Mobile Phones and Economic Development in Africa. *Journal of Economic Perspectives*, 24(3), 207–232.

Arokoyo, T. (2005). ICTs Application in Agricultural Extension Service Delivery. *In Proceedings of the CTA Annual Seminar*.

Asagba, P. O., & Omenesa, Z. E. (2010). Role of Information Communication Technology (ICT) in Agricultural Development in Nigeria. *Journal of Agricultural Extension,* 14(1), 34–45.

Asenso-Okyere, K., & Mekonnen, D. A. (2012). The Importance of ICTs in the Provision of Information for Improving Agricultural Productivity and Rural Incomes in Africa. *UNDP Working Paper*.

Ayuba, A., Alaku, A., & James, A. (2011). Enhancing the Production of Hungry Rice (Digitaria exilis) in Plateau State. *Nigerian Journal of Crop Science,* 3(2), 112–118.

Balaji, V., & Meera, S. N. (2001). Information and Communication Technology for Agriculture Extension in India. *ICT in Agriculture Sourcebook*.

Davis, K., & Addom, B. K. (2010). ICT and Agricultural Extension: Challenges for Developing Countries. *Journal of Agricultural Extension and Rural Development*, 2(4), 27–32.

FAO. (2005). e-Agriculture Strategy Guide: Piloted in Asia-Pacific Countries**.** Food and Agriculture Organization of the United Nations.

Gaol, T. V. L., & Gustira, M. R. (2020). Utilization of information and communication technology in agriculture. IOP Conf. Series: Materials Science and Engineering. doi:10.1088/1757-899X/879/1/012143

GSMA. (2020). The Mobile Gender Gap Report. GSMA Association.

Huang, H. M., & Liaw, S. S. (2010). Exploring User's Attitudes and Intentions Toward the Web as a Survey Tool. *Computers in Human Behavior,* 21(5), 729–743.

Jideani, I. A. (1999). Traditional and Possible Technological Uses of *Digitaria exilis* (acha) and *Digitaria iburua* (iburu)—A Review. *Plant Foods for Human Nutrition*, 54(4), 363–374.

Kante, M., Traore, M., & Tiemtoré, F. (2016). Harnessing Mobile Applications for Agricultural Development in West Africa. *CTA Technical Report Series*.

Koyani, B. K., Dalvi, V. D., Patel, G. R., & Dholariya, J. D. (2025). Role of Icts in extension for a sustainable agricultural development. *AgriGate- An International Multidisciplinary e-Magazine 5*(3).

Mane, V. S. (2024). The role of information and communication technology in promoting sustainable agricultural practices. *International*

Journal of Social Science & Management Studies (I.J.S.S.M.S.) Peer Reviewed– Refereed Research Journal, Indexing & Impact Factor - 5.2, 10(10).

National Agricultural Extension and Research Liaison Services (NAERLS). (2021). *Agricultural Performance Survey of 2021 Wet Season in Nigeria*. Ahmadu Bello University, Zaria.

NRC (National Research Council). (1996). *Lost Crops of Africa: Volume I – Grains*. National Academies Press.

NRC. (1996). *Lost Crops of Africa Volume I: Grains*. National Research Council, National Academy Press, Washington, D.C.

Okeke, C. C. (2014). ICT and Agricultural Development in Nigeria: A Case Study of National Agricultural Extension and Research Liaison Services (NAERLS). *Journal of Agricultural Technology, 10*(3), 567–579.

Okello, J. J., Al-Hassan, R., & Okello, R. M. (2014). A Framework for Analyzing the Role of ICT on Agricultural Commercialization and Household Food Security. *International Journal of ICT Research and Development in Africa*, 5(1), 1–16.

Olaniyi, A. (2013). Assessment of Utilization of ICTs for Sustainable Agricultural Extension Service Delivery in Nigeria. *International Journal of*

Advanced Research in IT and Engineering, 2(1), 1–15.

Opara, U. N. (2008). Agricultural Information Sources Used by Farmers in Imo State, Nigeria. *Information Development*, 24(4), 289–295.

Patel, K. K., Singh, V., Yadav, R., & Baheliya, A. K. (2024). Socio-economic impacts of Sustainable Agriculture. *International Conference on "Food & Nutritional Security through Agriculture Ecosystem.*

Waqar, M., Muneer, S. E. T., Aldosari, F. O., Baig, M. O., Xiong, X., Niaz, Y., Javed, M. S., Waqas, M. M., & Varun, N. (2021). Chand ICT important information tool for sustainable agriculture productivity. *International Journal of Biosciences | IJB | 18*(2)39-44. http://dx.doi.org/10.12692/ijb/18.2.39-44.

Wegner, T. (2009). ICT in Agriculture: Perspectives of Rural Farmers in Nigeria. *African Journal of ICT,* 5(2), 32–40.

Williams, C., Robinson, I., Nasir, M. M., & Kwaha, I. A. (2023). The impact of ICT in sustainable Agricultural farming in Adamawa State Nigeria. *Research Inventy: International Journal of Engineering and Science 13*(9). 5-12.

World Bank. (2011). *ICT in Agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions*. e-Sourcebook.