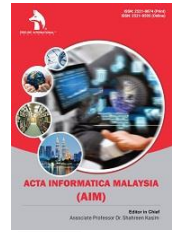


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RESEARCH ARTICLE

IMPACT OF ICTS USAGE ON SMALLHOLDER FARMER'S ADAPTATION STRATEGIES: A STRUCTURAL EQUATION MODELING STUDY IN NIGER STATEIsah Shehu Nabara^{a*}, Mohammad Yakubu^b, Abubakar Shehu Umar^c^aDepartment of Agricultural Science Education Niger State College of Education, Minna.^bDepartment of Crop Production Ibrahim Badamasi Babangida University, Lapai, Niger State^cDepartment of Agricultural Education Federal College of Education (Tech) Gombe State*Corresponding Author Email: nabaraisah@gmail.com

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ABSTRACT

The study was conducted in Kontagora Local Government Area of Niger State between June and August 2021. The purpose of this study was to determine how ICTs affected smallholder farmers' adaption strategies. 240 respondents were chosen at random using a multiple-stage random sampling procedure for the study. The levels were determined using frequency and percentages of summated scores by categorization into high moderate and low using range. The impacts of ICTs on adaptation strategies were determined using structural equation modeling (IBM SPSS Amos 20). The study revealed high-level adaptation strategies (M=3.69) and a moderate level of ICTs (M=3.51). The research also showed how ICTs affect adaptive strategies. The impact of radio ($\beta = 0.355$, CR = 4.145, P = .001), mobile ($\beta = .322$, CR = 4.111, P = .000), television, ($\beta = .211$, CR = 3.717, P = .000) on adaptation strategies were positive and statistically significant. The results recommends that planned interventions be carried out to coordinate ICT/telecommunications agencies with those in charge of adaptation policy and planning, notably National Adaptation Plans, for more efficient planning and implementation.

KEYWORDS

Adaptation, Farmers, ICTs, Smallholders, Structural equation modeling.

1. INTRODUCTION

The application of Information and Communication Technology (ICT) across different sectors of the global economy has become a game changer in boosting work efficiency and productivity. The agriculture sector in the global economy is one of the industries experiencing tremendous ICT application in all spheres of its operations. Radio, television, mobile phones, the internet, and other technologies fall under the general concept of ICT. The use of ICTs in agriculture improves production, market access, and weather adaptation (Salampasis and Theodoridis, 2013). Since 2010, increased food costs have contributed to the plight of over 40 million people worldwide, necessitating the need for more efficient agricultural treatments (Stein, 2011). By 2050, there will be 9 billion people on the planet, which will increase demand for food and strain already-scarce resources (Ghose, 2014). Even after years of industrialization and expansion in the service sector, agriculture still contributes one-third of Nigeria's GDP and three-quarters of all jobs (Obasan and Adediran, 2011).

Over 60 percent of the labour force in countries with per capita incomes in the range of US\$ 400 to 1,800 range works in agriculture (World Bank, 2019). The arid-north region of Nigeria is already experiencing extreme heat and reduced rainfall as a result of climate change, while the Sahel region receives less than 10 inches of rain per year, which is 25% less than thirty years ago (Chukwuezie et al., 2016). According to the intergovernmental panel on climate change (IPCC) the situation might worsen by 2100, when worldwide rainfall will have decreased below 10%. The agriculture sector has experienced a new technological revolution for the past ten years (Ali et al., 2016). Compared to a decade earlier, this new

technological revolution, has the potentials to respond to farmers' needs accurately and swiftly.

Daum (2020) observed that in recent years, ICTs had become one of the main driving tools used by farmers to manage the essential factors of production in agriculture. ICT applications have the potential to identify and find solutions to some of the numerous problems faced in the field of agriculture, which includes prolonged droughts, pest and disease outbreaks, seasonality and spatial dispersion of farming; high transaction costs and information asymmetry (Anh et al., 2019).

The capacity of information and communication technologies to produce and disseminate information, to facilitate the coordination of various actors within and outside of the government, and to improve the efficiency of business, development, and government processes has resulted in an increasing impact on economic and social development over the past two decades (Ali et al., 2016). These three skills are just as important for other fields as they are for adapting to climate change.

However, compared to other development sectors like health and education, the amount of experience with ICT deployment for coping with climate change is currently less (Creech & Parry, 2014). ICTs also have a complicated connection to sustainability and the root of climate change (Papa et al., 2015). The influence of ICTs can be used to explain this relationship. ICTs have a significant impact on productivity growth in intensive agriculture (Rengaraj & Shibu, 2022). As more particular lessons and consequences are discovered, conducting impact studies and sharing information from pilot projects are essential for ICT success (Wroski, 2019). Different ICT applications in agro climatology have been developed

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as a result of the rapid expansion of ICT applications across all industries to help farmers quickly obtain information. This study's specific goals are to: assess the degree of ICT (mobile, radio, and television) usage and adaptation techniques; and look at how ICT usage affects smallholder farmers' adaption strategies.

2. RESEARCH FRAMEWORK

This study is based on the proposed framework shown in Figure 1. The approach takes into account how ICTs (radio, mobile phones, and television) affect smallholder farmers' risk-reduction and risk-management methods in order to assist them prepare for the physical effects of climate change (Adaptation strategies)

3. METHODOLOGY

3.1 Study Area

This study was carried out in Kontagora area of Niger State from June to August 2021 for the agricultural season. A multi-stage sampling technique was used for the study. In the first phase Zone iii was selected out of the 3 Agricultural Development Programme (ADP) zones in Niger state. In the second phase, Kontagora was carefully chosen out of eight (8) Local Governments in Zone iii. The third phase, 4 wards were selected. In the fourth phase, 240 farmers were carefully chosen purposively who were using ICTs in farming activities as shown in Table 1 below:

Interviews and questionnaires were used to gather the data. Firstly, the level of adaptation strategies was determined using frequency and percentages of summated scores by categorization into high moderate, and low range. The level of ICTs as perceived by individual farmers was to provide a true picture of what is on the ground at the time of conducting this study. In addition, the impact of predictor variables on the outcome variables (ICTs on adaptation strategies) was determined using structural equation modeling (IBM SPSS Amos 20). The validity of the measurement

model was assessed first, and then the structural model was put to the test. In the initial stage, confirmatory factor analysis (CFA) was employed. Its goal is to determine whether the measurement model is accurate. The construct validity and acceptable levels of Goodness-of-Fit (GOF) are the two requirements for the validity of the measuring model (Hair et al., 2010). The normed Chi-square χ^2/df , the comparative fit index (CFI), the adjusted goodness-of-fit index (AGFI), the non-normed fit index (NNFI), the goodness-of-fit index (GFI), the normed fit index (NFI), the parsimonious goodness-of-fit index (PGFI), the root mean square error of approximation (RMSEA), and others are some of the commonly used goodness-of-fit indices. Three construct validity indicators to take into account are standardized factor loadings, average variance extracted (AVE), and construct dependability (CR).

After the measurement model had been verified, the structural model was estimated. The second stage involved running SEM and compiling the GOF indices using the same evaluation standards as CFA. The path coefficients were then interpreted along with the structural equation fit (R2). $\chi^2 = 1258.541$, $df = 624$, $p = 0.000$, $CFI = 0.915$, $RMSEA = 0.053$ (90 percent confidence for $RMSEA = 0.041-0.048$), and $normed \chi^2 = 2.13$ are the goodness-of-fit indices for the model. Generally speaking, CFI values of 0.9 are considered adequate (Hair and Patel, 2014). A normed Chi-square of 3 or less is associated with better fit, and the RMSEA should be between 0.03 and 0.08 (Hair et al., 2010).

3.2 Variable Measurement and Estimation Procedures

The conceptual model's constructs' relationships with one another were estimated using structural equation modeling (SEM). Even though the emphasis was on the core characteristics of ICTs, radio, mobile phones, and adaption techniques were also discussed. The goal of the estimation was to figure out the ICTs usage of farmers to gauge the impacts on adaptation strategies. Respondents were asked how they agreed or disagreed on a five-point Likert scale as indicated in Table 2.

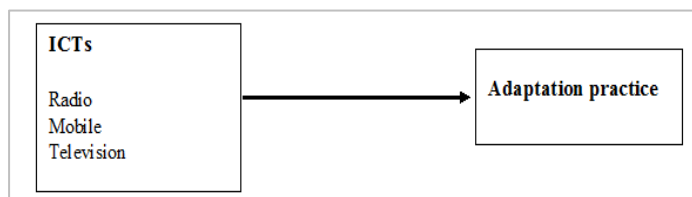


Figure 1: Research Framework



Figure 2: Map of Niger State Showing Kontagora LGA

Zone	District	Wards	Population	Sample
Zone III	Kontagora	Madara	921	90
		Usubu	277	35
		Masuga	485	45
		Nagwamatse	711	70
			2,394	240

Table 2: Indicator Variables in the Model Observed.

Item	Description	Measurement		
RD1 RD2 RD3	ICTs usage (Radio, Mobile phone, Television)	5-point Likert scale (disagree to agree)		
MP1 MP2 MP3				
TV1 TV2 TV3				
AD1 AD2 AD3			5-point Likert scale (disagree to agree)	
			Adaptation strategies	

RD= Radio, MP=Mobile phone, TV= Television, AD= Adaptation

4. RESULTS AND DISCUSSION

4.1 Level of Adaptation Strategies

According to Table 1, the majority of respondents prioritized irrigation as a climate change adaptation strategy (M = 4.65), followed by cover coping (M = 4.50), drought-resistant varieties, and Organic matter all at moderate levels. Therefore, this can be attested that smallholder farmers had played a significant role in the use of adaptation practices towards climate change impact in the study area as the overall mean score signified a high level of adaptation strategies (M=3.96). This outcome is in line with earlier research by Jha et al. (2018) on the adoption of adaptation techniques to deal with the effects of climate change.

4.2 Level of ICTs Usage

Data relating to respondents' ICTs usage levels are presented in Table 2. The table shows the highest proportion of the respondents uses the Mobile phone (M=4.10). However, a moderate level was shown on Radio (M=3.33) and television (M=3.11). Therefore the overall mean score on ICTs (M=3.80) signifies a moderate level on the usage of ICTs. The usage ICTs increase farm productivity, and adaptability to weather conditions in agriculture (Gangopadhyay et al., 2019). The use of ICTs helps one to acquire necessary technical skills and knowledge towards a logical and progressive attitudinal change which may result in improved performance of farmers' productivity (Sima et al., 2020).

Due to direct communication between the farmer and the extension agent regarding the topic of adaptation and other associated agricultural practices, mobile phones have decreased the distance between farmers

and extension research centers. According to a research, the internet, mobile phones, radio, and television were the most significant media for educating farmers about agriculture (Chhachhar et al., 2014).

4.3 Impact of ICTs on Adaptation Strategies

4.3.1 Measurement Model

The findings of the measurement model frequently in Table 3 show a good fit. All standardized factor loadings that are statistically significant should be at least 0.5 (Hair et al., 2010). The loading suggests that the observed indicators are strongly linked to the structures with which they are associated. Additionally, it supports construct validity (Hair et al., 2010). All standardized factor loadings in our model are statistically significant. The bulk of factor loadings are more than 0.5, CR stands for convergent validity. Strong reliability is indicated by a CR of 0.7 or higher. Most of the constructs in our model have CR values larger than 0.7. A CR of less than 0.7 is acceptable if the research is exploratory in nature (Hair & Patel, 2014). Average Variance Extracted (AVE) is another convergent validity indicator, and convergence is good when the AVE is 0.5 or more (Hair et al., 2010). The AVE values for all constructs in our model are greater than 0.5, as shown in Table 3, which is acceptable.

The other relevant indicators (factor loadings) are within acceptable bounds, meaning that convergent validity is acceptable. When the square root of the AVE is greater than the correlation between the components, discriminant validity of the construct is attained (Afthanorhan, 2014). The extent to which a test or measurement differs from (that is, does not correlate with) a measurement whose underlying construct is conceptually unconnected to it (Hair et al., 2010). As depicted in Table.

Table 1: Level of Adaptation Strategies of Respondents

Adaptation practice	Mean	Level
Irrigation	4.65	High
Drought-resistant varieties	3.10	Moderate
Cover crops	4.50	High
Organic matter	3.60	Moderate
Total Mean	3.96	

Table 2: Level of ICTs Usage

ICTs usage	Mean	Level
Mobile	4.10	High
Radio	3.32	Moderate
Television	3.11	Moderate
Total Mean	3.51	

Table 3: Factor loadings, Average Variance Extracted and Construct Reliability

Constructs	Items	Factor Loading	CR (Above 0.6)	AVE (Above 0.5)
Radio	RD1	0.66	.76	.63
	RD2	0.81		
	RD3	0.74		
Mobile phone	MP1	0.81	.80	.62
	MP2	0.77		
	MP3	0.86		
Television	TV1	0.65	.82	.61
	TV2	0.76		
	TV3	0.85		
Adaptation strategies	AD1	0.74	.85	.60
	AD2	0.86		
	AD3	0.77		

CR=Construct reliability, AVE= Average Variance Extracted

Table 4: Discriminant Validity of the Constructs

Construct	RD	MP	TV	AD
RD	0.822			
MP	-0.188	0.779		
TV	0.497	0.046	0.784	
AD	0.403	- 0.220	0.164	0.809

Note: on the diagonal (bold) represent AVE while off-diagonal represent correlation coefficients

The structural model's results show that it fits well. The relative χ^2 (Chisq/df) is 2.444 (achieved), which is below the acceptance level of 5.0; other fit indices include AGFI = 0.834 (not achieved), GFI = 0.834 (not achieved), CFI = 0.919 (achieved), IFI = 0.916 (achieved), TLI = 0.933 (achieved), and RMSEA = 0.638 (achieved). As previously stated (Hair et al. 2010). The goodness-of-fit indices of the correlation output structural model are shown in Table 5 below.

Table 6 summarizes the results of the structural model with a structural path estimate of a significant effect of ICTs on adaptation strategies. The standardized coefficients are ($\beta = 0.355$, CR = 4.145, P = .001; $\beta = .322$, CR = 4.111, P = .000; $\beta = .211$, CR = 3.717, P = .000). The findings reliably support the conceptual model, with all estimated path coefficients being statistically significant. For our primary construct, adaptation strategies,

the squared multiple correlations (R^2) is 56.1%. That signifies the important factors in our model can account for over 56.1% of the variation in adaptation strategies. In other words, the influence of the predictor variable on the outcome variable in this study has been confirmed. This showed that radio was a popular medium of communication and that it broadcasted numerous adaptation programs, while television also made significant contributions to the dissemination of knowledge regarding adaptation to climate change in the region. The distance between farmers and Extension Agents has been closed by mobile phones. Before making any adjustments to their farms, farmers consulted the metrological agency for the most recent weather information. According to the findings of this study, the predictor variable has contributed to the outcome variable in a relative sense as shown in Table 6 below.

Table 5: Goodness-of-fit Indices of Correlation Output Structural Model

Name of category	Name of Index	Recommended Value	Value (Results)
Absolute Fit	Chi- square	> 0.05	0.000*
	RMSEA	< 0.08	0.638
	GFI	> 0.9	0.811**
Incremental Fit	AGFI	> 0.9	0.721**
	CFI	> 0.9	0.919
	TLI	> 0.9	0.933
	IFI	> 0.9	0.916
Parsimonious Fit	Chisq/df	< 5.0	2.444

Note: *Not applicable for large sample (more than 200). **Not achieve the accepted level

Table 6: Regression Results

Regression path		β	C.R.	P
ADP	<--- Radio	.355	4.145	.001
ADP	<--- Mobile	.322	4.111	***
ADP	<--- Television	.211	3.717	***

Significant at 5% level of significance

$R^2 = 56.1\%$

5. CONCLUSIONS AND RECOMMENDATIONS

In this respect, the current study concludes that smallholder's adaptation strategies towards climate change in Kontagora were encouraged due to exposure to ICTs which positively contributed towards smallholder adaptation practice. The ICTs created awareness to smallholder farmers on various adaptation practices towards climate change impact on farming activities. The identification of the importance of ICTs can enable the policymakers in creating climate change adaptation options. Therefore the following recommendation were made

- Enhance ICT integration capabilities for national strategic adaption plans: ICT/telecommunications government professionals should be brought together with those in charge of adaptation policy and planning (especially National Adaptation Plans) in order to collaborate for more effective planning and implementation.
- Increase the private sector's involvement in planning and execution: ICT infrastructure should be built nationwide through public-private partnerships (PPP) to guarantee access to ICT technology. To deploy ICTs in agriculture, accessible communication and power infrastructure should be created in rural regions.

More needs to be done to strategically involve the private ICT industry and examine how privately motivated application interests could either directly or accidentally boost adaptation while also providing financial profit.

- To overcome the scarcity of ICT skills, the government and NGOs should educate farmers about the advantages of adopting ICTs and make ICT education mandatory in schools, colleges, and

universities. The inclusion of ICT-relevant activities should be viewed as a window of opportunity in adaptation plans. A capacity-building program to evaluate where and how investments in ICTs might be most integrated should be part of the preparation for these.

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