Factors Influencing Indigenous Technology Utilization for Climate Change Mitigation Among Arable Crop Farmers in Ekiti State, Nigeria

B. A. Ayolo[1] and O. B. Adeniji[2]

[1,2]Department of Agricultural Economics and Extension, Federal University Oye Ekiti, Ekiti State, Nigeria.

[1]E-mail: abdul.bakare79@gmail.com
[2]E-mail: dimejiadeniji@gmail.com

Abstract. Agricultural practices have been affected by climate variability which is a global issue that Smallholder Arable crop farmers must tackle for increased productivity. This study assessed factors influencing the use of indigenous technology for mitigating the effect of climate change and specifically identify indigenous technologies used for mitigating climate change among arable crop farmers and isolated and categorized variables that influenced the use of indigenous technology to mitigate climate variability. Simple random sampling technique was used to sample 340 respondents who are arable crop farmers. Data collected were factor analyzed, results showed that four factors were loaded and named as personal characteristics factor, interpersonal relationship factor, institutional factor and educational related factor**.** Factor 1 accounted for 25.62% of the variance in the benefit of indigenous technologies and was labeled "Personal Characteristics, factor 2 explained 20.96% and was labeled "Interpersonal Relationships, factor 3 an institutional factor, contributed approximately 12.81%, factor 4 related to education, contributed about 8.48%. It was concluded that the four critical factors that influence indigenous technology utilization among arable crop farmers were personal characteristics, interpersonal, institutional and educational factors. Therefore, it was recommended that any effort to mitigate climate change through indigenous technology must focus on the above factors in designing any programe for effectiveness. Government and researchers can take advantage of this recommendations to have a fruitful effort in the mitigation strategies for climate change.

Keywords. Climate change, Mitigation, indigenous, Technology, Arable crops.

1. Introduction

Climate change is a global phenomenon that significantly impacts livelihoods, particularly in agriculture, forestry, and fisheries. Sub-Saharan Africa faces unique challenges due to limited adaptive capacity, making it highly vulnerable to climate change [1-3]. Small-scale farmers in this region are especially affected, experiencing serious repercussions on crop and animal production as well as income. In some cases, climate change has displaced farmers, leaving them landless and homeless [4,5].

To mitigate these impacts, various innovations have been employed globally. Deressa and Hassan (2009) found that simulation models could significantly reduce climate change's effect on net crop revenue per hectare in Ethiopia by 2050 and 2100. Additionally, [6], estimated that this region could

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experience an annual long-term GDP loss of $5 billion under a 2°C global temperature rise by 2100 if appropriate mitigation strategies are not implemented. Nigeria, in particular, remains highly susceptible due to its heavy reliance on rainfall for agriculture (Federal Ministry of Environment [7,8].
The projected consequences of climate change pose significant economic threats to Nigeria. Research suggests the country could lose between 6% and 30% of its GDP by 2050 if it fails to implement adaptive strategies [7]. Nigeria is also expected to experience an increase in crop risks due to climate change (Alliance for Green Revolution Africa [9]. Crop modeling studies indicate that even with increased precipitation, rising temperatures will likely have negative long-term effects on rain-fed crop production [8].
Smallholder arable crop farmers in Nigeria face numerous climate change-induced challenges, including flooding, pest and disease invasions, high temperatures, and unpredictable rainfall patterns. The Nigerian government has introduced several adaptation measures, such as improved crop varieties, fertilizers, irrigation schemes, and geodata, to address these issues [11]. However, as [10] argue, farmers' vulnerability is influenced not only by climate change itself but also by societal capacity to adapt and recover. Factors such as land use and cultural practices play significant roles in adaptation capacity [12].
Historically, societies have demonstrated adaptability by utilizing indigenous technologies to cope with climate variations. African farmers have long relied on indigenous knowledge to interpret weather patterns and make informed agricultural decisions. These strategies have enabled them to adjust to climate changes effectively. For example, Nigerian farmers have historically switched from drought-susceptible maize varieties to more resilient ones. Other adaptive strategies include altering planting dates, expanding irrigation, increasing fadama farming, and modifying land use and management practices.
Indigenous technologies refer to traditional, community-based methods that have evolved over time to address environmental challenges. These include ecological farming techniques that emphasize biodiversity and soil conservation, which enhance climate resilience. Unlike modern technologies, which often rely on external inputs such as synthetic fertilizers and mechanization, indigenous technologies are rooted in local knowledge and sustainable resource management. Since no single solution applies universally, agricultural managers must integrate locally appropriate indigenous strategies to maximize their effectiveness.
Mitigating climate change requires small-scale farmers to develop proficient skills in indigenous technologies. The efficacy of these methods depends on farmers' technical knowledge and application skills. For instance, the National Bureau of Statistics [8], reported that 70% of fruits and vegetables produced in Nigeria are wasted due to traditional but inefficient farming methods. Farmers must, therefore, refine their techniques to address climate variables such as temperature fluctuations, drought, wind, erosion, and flooding.
A lack of technical training and participatory decision-making mechanisms exacerbates socioeconomic vulnerabilities and limits communities' adaptive capacities. Fortunately, many farmers have experience with indigenous technologies that have been successfully used for generations. However, the urgency to develop comprehensive climate adaptation strategies extends beyond historical coping mechanisms. Effective solutions require collaboration among stakeholders to address present and future climate challenges.
Despite these challenges, many African smallholder farming communities have demonstrated resilience for decades, continuously modifying and passing down indigenous techniques [13]. While modern technological innovations are emerging as key tools for climate adaptation, there remains limited knowledge about the technical factors influencing the effectiveness of indigenous technologies. Understanding these factors is crucial for designing sustainable solutions to poor yields and low income among farmers in Ekiti State, Nigeria. This study aims to identify indigenous technologies used for climate change mitigation and assess factors influencing their utilization to enhance agricultural sustainability.

2. Methodology

2.1. Study Area

The study was carried out in Ekiti State, Nigeria (Figure 1). Ekiti State consists of 16 Local Government Areas and is situated between longitudes 4° 51'' and 5° 45'' East of the Greenwich Meridian and latitudes 7° 15' and 8° 5' North of the Equator. The state falls within the rainforest zone of Nigeria.

Ekiti State shares borders with:

- South: Ondo State
- North: Kwara State
- East: Kogi State
- West: Osun State

The climate of Ekiti State is characterized by a mean annual rainfall of 2,000–2,400 mm and a temperature range of 20–27°C. The state covers a land area of 6,353 km². According to the 1991 Census, Ekiti had a population of 1,647,822, while its estimated population upon its creation on October 1, 1996, was 1,750,000, with its capital located at Ado-Ekiti.

The terrain of Ekiti State is predominantly upland, rising above 250 m above sea level. It lies on metamorphic rock formations of the basement complex and features an undulating landscape with step-sided outcrop dome rocks, often occurring singularly or in clusters. Prominent rock formations are found in Efon-Alaaye, Ikere-Ekiti, and Okemesi-Ekiti. The state is dotted with rugged hills.

In recent years, Ekiti has experienced increasing environmental challenges such as deforestation, localized temperature rise, erosion, mining, wildfires, delayed rains, heat spikes, and intense weather events, making it increasingly vulnerable to climate change impacts.

2.2. Sampling Procedure and Sample Size

A multistage sampling technique was employed for sample selection.

- Stage 1: Due to the predominance of arable crop farming, Ekiti State was purposively selected for the study.
- Stage 2: Out of the 16 Local Government Areas, 12 were purposively selected based on their level of rurality and farming activities.
- Stage 3: From each of the 12 selected Local Government Areas, two villages were purposively chosen based on the intensity of arable crop production.
- Stage 4: In each village, 15 smallholder arable crop farmers were interviewed, resulting in a total of 360 respondents.

However, after data cleaning, 340 copies of the questionnaire were found to be usable for analysis.

2.3. Data Collection and Analysis

A structured interview schedule was used to collect data from the respondents. The collected data were analyzed using descriptive statistical methods and Principal Component Analysis (PCA) of Factor Analysis. This method was used to isolate and categorize variables that influenced the use of indigenous technology for climate change mitigation into distinct factors.

3. Results and Discussion

3.1. Technology Utilized for Mitigating Climate Change

It was observed in Table 1 that respondents indicated their utilization of all the identified technologies at high percentage, which ranges from 90.1% to 100% while only two of the identified technologies (the use of pesticides and consultation of rainmakers) with 46.6% each. This implies that the use of pesticides and rainmakers to draw rain especially during drought are not popular among the respondents. However, a vast number of them extensively utilized the other mitigation strategies such as planting of early maturing crops, changing planting time, planting of drought resistant crops, mulching, intercropping to prevent crop failure and problem of income flow, zero tillage and mixed cropping and farming among others. This means that most of the farmers have preference for the emerging technologies compared to the indigenous ones with low percent of utilization. The preference for modern technologies for mitigating climate change may be due to effectiveness as Deressa and Hassan [14], opined that modelling simulation is found to reduce the effect of climate change drastically if used. It is also worth noting that adopting modern technologies is not only improving the production efficiency but also reflects the farmers' ability to adapt to ongoing climate changes, which significantly contributes to achieving food security and sustainable development in the long term**.**

Table 1. Technology used for climate change mitigation.

Technology used**	Frequency	Percentage
Planting early maturing crops	324	94.5
Planting time	343	100
Drought resistant crops	343	100
Mulching	343	100
Irrigation	334	97.4
Farming methods	340	99.1
Intercropping	310	90.4
zero tillage	343	100
Making ridges	343	100
Mixed cropping	340	99.1
Mixed farming	312	91.0
Planting of trees	332	96.8
Use of manure	341	99.4
Fertilizer applications	320	93.3
Avoid Bush burning	323	94.2
Avoid felling of trees	332	96.8
Drainage system	332	96.8
Use of pesticides	160	46.6
Consult rainmaker	160	46.6
Cover cropping	309	90.1

Source: Field Survey, 2022.
**Multiple responses given.

3.2. Factors Influencing Utilization of Indigenous Technology

Results of the Principal Component Analysis showing the isolation of variables that influence the usage of indigenous technologies for climate change mitigation. The KMO of 0.416 and Bartlett's test of Sphericity of 4171.791 at P< 0.000 is an indication that the sample for the study was adequate to conduct factor analysis.

Table 2. KMO for sample adequacy.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.416
Bartlett's Test of Sphericity	Approx. Chi-Square	4171.791
	Df	210
	Sig.	0.000

Results in table 3 show that four factors were significantly loaded and retained as shown in the outputs of the factor analysis conducted. Factor analysis was used to interpret the data, where factors were selected based on the eigenvalues, which indicate the extent to which each factor contributes to explain the total variance of the data. The 'Varimax' rotation technique was also applied to improve the interpretability of the factors, as this technique helps to make the loadings on the factors more clear and easier to interpret.

The four retained and loaded factors cumulatively accounted for 67.84% of the variations in the utilization of indigenous technology by the small-scale arable crop farmers in the study area. The four loaded and retained factors are: personal characteristics factor, interpersonal relationship factor. Institutional factor and educational related factor.

It was observed from table 3 that factor 1 with an eigen value of 5.381 contributed about 25.625% variations to the utilization of indigenous technologies by arable crop farmers, factor 2 with an eigen value of 4.402 contributed about 20.96% variation, factor 3 with an eigen value of 2.69 contributed

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about 12.809% variation to indigenous technology utilization and factor 4 with an eigen value of 1.781 contributed about 8.48% variations.

Factors 1 and 2 together contributed a total 46.585% variability in the utilization of indigenous technology by smallholder arable crop farmers in the study area. This indicates that the utilization of indigenous technology in the study area can be more effective if these major factors are priotized and given special consideration. This means that personal characteristics of the farmers and interpersonal relationship factors greatly influenced the utilization of indigenous technologies for mitigating climate change by the arable crop farmers in the study area and this will go a long way in improving farmers' productivity. This table presents the results of factor analysis using Principal Component Analysis with Varimax rotation, revealing a set of factors that explain a significant portion of the total variance, with the first four components accounting for approximately 67.87%. The positive and negative values indicate the strength and direction of the relationship between each variable and the identified factors. Positive values signify a direct relationship, meaning that as the factor increases, the variable's influence or response also increases. Conversely, negative values indicate an inverse relationship, where an increase in the factor corresponds to a decrease in the variable's influence. For example, negative scores associated with gender or farming experience suggest that higher levels of these factors may be linked to a reduced impact or response in the studied variables, while positive scores such as access to credit or extension services imply that higher levels of these factors are associated with greater influence. These values help in understanding how different factors affect the studied phenomenon, allowing researchers to identify and rank the most influential variables based on the strength and direction of their relationships.

Table 3. Results of factor analysis using Principal Component with Verimax Rotation.

	Component			
	1	2	3	4
Gender	-0.69	0.53	-0.20	-0.26
Age	0.69	-0.01	0.06	-0.30
Marital status	-0.29	0.29	-0.29	0.20
Education background	-0.75	0.02	-0.02	0.50
Source of income secondary	0.31	0.38	-0.32	0.42
Household size	0.46	-0.73	0.18	-0.30
Farm size	0.13	-0.74	0.25	0.35
Farming experience	0.40	-0.55	-0.07	0.07
No of association	0.10	0.25	0.55	0.14
Land ownership	-0.02	-0.09	0.08	0.16
access to credit	0.75	0.36	-0.04	0.33
farmers should have farming experience	0.69	0.04	0.55	-0.24
farmers should possess agric skills	0.71	0.32	0.00	0.45
there should be land ownership for farming	0.71	0.55	0.26	-0.27
crop fields influence the the indgenous tech used	0.58	0.07	-0.42	0.28
distance from water resources to the farm	-0.21	0.55	0.69	0.03
farmers access to credit facilities	-0.50	0.65	-0.11	-0.42
farmers access to extension agents	-0.36	-0.09	0.75	0.37
farmers access to info on climate	0.09	0.71	-0.10	0.22
access to indigenous technology	0.45	-0.11	-0.66	-0.10
farmers-to-farmers extension services	0.53	0.80	0.11	-0.05
Eigenvalues	5.381	4.402	2.69	1.781
Percentage variation (%)	25.625	20.96	12.809	8.48
Cumulative %				67.874

Source: Field survey, 2022.

3.3. Factors Naming/Description

Variables that contributed to factor 1 were: gender (L=-0.69), age= (0.69), educational background= -(0.75), access to credit=0.75, farmers' farming experience=0.69, farmers' agricultural skills=0.71, land ownership=0.71, crop field=0.58, farmers-to-farmers extension services=0.53. the loadings for all these variables loaded above 0.50 they were all related to the personal characteristics; thus, they were named personal characteristics factor. This factor has an eigen value of 5.381 and contributed 25.625% to all the factors identified. This means that gender, Age, educational status, access to credit, farming experience, agricultural skills, land ownership, crop fields and farmer-to-farmer extension service influenced the utilization of indigenous technologies for mitigating climate change in the study area as shown in Table 4.

Table 4. Factor 1: personal characteristics.

	Factor 1 Loadings
Gender	-0.69
Age	0.69
Education background	-0.75
Access to credit	0.75
Farmers should have farming experience	0.69
Farmers should posses agric skills	0.71
There should be land ownership for farming	0.71
Crop fields influence the the indgenous tech used	0.58
Farmers-to-farmers extension services	0.53

Source: Field Survey, 2022.

3.3.1. Interpretation of Principal Component Analysis (PCA) – Factor 2 Loadings

In PCA, factor loadings indicate the correlation between the original variables and the extracted principal components. Loadings closer to +1 or -1 suggest a strong relationship with the factor, while values closer to 0 indicate a weak association. Below is an interpretation of Factor 2 based on the given loadings:

- Gender (0.53)

A positive loading suggests that gender influences Factor 2. This implies that gender differences may play a role in how farmers adopt indigenous climate change mitigation strategies.

- Household Size (-0.73)

A strong negative loading indicates that larger household sizes may negatively impact the factor. This could suggest that households with more members might struggle with resource allocation, potentially reducing the efficiency of climate adaptation strategies.

- Farm Size (-0.74)

A strong negative correlation suggests that larger farm sizes are inversely related to Factor 2. This could indicate that smaller farms are more likely to be associated with the practices represented by this factor, possibly due to greater dependency on local adaptation strategies.

- Farming Experience (-0.55)

The negative loading suggests that farmers with more years of experience may be less influenced by Factor 2. Experienced farmers might rely more on traditional knowledge rather than external information or financial support.

- Land Ownership for Farming (0.55)

A positive correlation indicates that land ownership is an important factor in adopting indigenous climate change mitigation techniques. Farmers who own land might have more stability and willingness to implement long-term sustainable practices.

- Distance from Water Resources to the Farm (0.55)

A positive loading suggests that access to water sources is a significant factor. Farms closer to water resources may be more adaptable to climate changes, as they can implement irrigation or water conservation strategies more effectively.

- Farmers' Access to Credit Facilities (0.65)

A moderately strong positive loading indicates that access to financial resources influences the factor. Farmers who can secure credit may invest more in adaptation strategies such as improved irrigation, better seeds, or climate-smart technologies.

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- Farmers' Access to Information on Climate (0.71)

A strong positive loading suggests that access to climate information plays a key role in Factor 2. Farmers who receive timely and accurate climate forecasts are more likely to adopt strategies that mitigate climate risks.

- Farmers-to-Farmers Extension Services (0.80)

The highest positive loading (0.80) indicates that peer-to-peer learning and knowledge sharing among farmers is a major contributor to this factor. This highlights the importance of community-based extension services in spreading climate adaptation strategies.

Based on the findings, it was also observed that factor 2 contributed 20.96% with an eigen value of 4.042, this means that household size, farm size, land ownership, access to information on climate change and distance from water resources are factors to be reckoned with in terms of their influence in the utilization of indigenous technology for mitigating climate change in the study area as shown in Table 5.

Factor 2 appears to represent institutional support and access to resources for climate adaptation. The variables with strong positive loadings (access to credit, climate information, and farmer-to-farmer extension services) suggest that this factor is driven by financial, informational, and social support systems. Conversely, the negative loadings on household size, farm size, and farming experience suggest that larger, more experienced, and resource-stretched households may face greater barriers in using these strategies

Table 5. Factor 2: Intrapersonal relationship factor.

	Factor 2 Loadings
Gender	0.53
Household size	-0.73
Farm size	-0.74
Farming experience	-0.55
There should be land ownership for farming	0.55
Distance from water resources to the farm	0.55
Farmers access to credit facilities	0.65
Farmers access to info on climate	0.71
Farmers-to-farmers extension services	0.80

Source: Field Survey, 2022.

Based on the findings, factor 3 has an eigen value of 1.781 with variation of 8.48%. this implies that the factors such as: number of associations the arable crop farmers belong to, farmers' access to extension agents and farming experience are institutional factors that influence the usage of indigenous technologies by the arable crop farmers for mitigating climate change in the area, in addition to that, it also enhances these factors through improved institutional support, facilitating access to associations, and providing training and experience can significantly contribute to increasing farmers' reliance on indigenous technologies that help mitigate the effects of climate change in the area.

Table 6. Factor 3: Institutional factor.

	Factor 3 Loadings
No of association	0.55
Farmers should have farming experience	0.55
Distance from water resources to the farm	0.69
Farmers access to extension agents	0.75

Source: Field Survey, 2022.

Results of Table 7 show that the only variable that loaded above 0.5 under factor 4 was educational background, thus, the factor was named *educational related factor*. This shows that education is a critical and significant factor that may contribute to the usage of indigenous technologies among arable crop farmers in mitigating the effect of climate change in the study area. This factor has an eigen value of 1.781 and contributed 8.84% according to the table 3 above, the variations that may result from the usage of indigenous technologies in ameliorating the consequences of climate change on arable crop production among farmers in the study area.

Table 7. Factor 4: Educational related factor.

	Factor 4 Loading
Education background	0.50

Source: Field Survey, 2022.

Conclusion and Recommendations

Based on the above findings, it was concluded that arable crop farmers in the study area had preference for modern technologies despite the abundance of indigenous technologies that could be used for mitigating the effect of climate change. It was also discovered that four major factors were identified to influence climate change mitigation. These were identified as personal characteristics of the farmers, interpersonal relationship, educational related and institutional factors. Critical consideration of these factors would create a sustainable pathway for the usage of the available technologies for mitigating the effect of climate change among arable crop farmers in the study area. Stakeholders like the government and agricultural extension workers working with the farmers in reducing the effects of climate change must consider these factors in designing a programme that would sustainably reduce the effects of climate change on the farmers and encourage the importance of community-based extension services in spreading climate utilization strategies for improved productivity.

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