Research Article

Resilience Building Mechanism to Mitigate Effects of Climate Change by Yam Farmers in Benue State, Nigeria

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Abstract | Resilience building mechanism to mitigate effects of climate change by yam farmers in Benue State, Nigeria was investigated in this study. One hundred and eighty (180) yam farmers were sampled for the study. Primary data was gathered with the use of interview schedule. Descriptive statistics and regression were used to analyze data collected. The result shows that the mean age of the farmers was 45.3 years and 83.3% were males. The result also shows that weather forecast (Mean=1.42) and change in farming type (crop- livestock Mean=1.36) were not commonly used by farmers meanwhile the farmers preferred planting of early maturing yam seed (Mean=3.58), use of mulching (Mean=3.46), crop rotation (Mean=3.27), organic fertilizer (Mean=3.07) and cover crops (Mean=3.05). The result of regression analysis showed that coefficient value of farm size (p=0.017) and membership of cooperatives (p=0.013) positively enhanced resilience building used to mitigate the effects of climate change. The study further averred that inadequate finance, traditional belief, and inadequate access to new technologies were serious constraints encountered by yam farmers. The study recommends that government in collaboration with development agencies should intensify effort in creating awareness to farmers on the several ways of building resilience to mitigate the menace of negative influence of climate change.

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Introduction

A change in the pattern of global weather resulting to serious conditions like rainfall, drought, temperature, floods, and drought is known as climate change (Mbah *et al*., 2016). In Sub-Sahara African Countries, changes in climate is the topmost factor causing weather variability that poses challenges to crop farmers, most especially the small-scale farmers who are the largest producers of staple food (Mkwambisi *et al*., 2021). Significant effects of change in climate on crop production in Nigeria include drought (Chukwunonso, 2015), flooding (Iheoma, 2015), leaching (Nwalem *et al*., 2019), dryness of germinated or transplanted seedlings (Babatolu and Akinnubi, 2016) and length of germination period (Izuogu *et al*., 2021).

Resiliency can be described as the means by which someone to predict, manage, bear and survive the consequence of dangerous occurrences in an efficient and timely manner by adopting long lasting measure of its crucial functions and structure (IPCC, 2009). Therefore, climate resilience methods are often termed as adaptive capacity or buffer capacity (Acevedo *et al*., 2020; Izuogu *et al*., 2021). Studies have shown that cultivation of climate resilient crops is one of the strategies through which farmers could adapt the climate change effects (Gyimah *et al*., 2020; Oguntade *et al*., 2010). The climate-resilient crops are improved crops with greater tolerance to stresses from biotic and abiotic sources. Unlike some indigenous crops seed that produce low yield as a result of unfavorable weather conditions, the improved crop seed are developed to increase produce by adapting adverse weather conditions like as heat, drought, flood, salinity and freezing (Dhankher and Foyer, 2018).

The IPCC describe adaptation as the adjustment in human or natural systems through innovation or changing environment (IPCC, 2007). In other words, climate change adaptation (resilient building mechanisms) implies the ability of a system to cushion potential impacts of climate change and to cope with the outcomes (Ashfaq and Jan, 2019). In relation to yam cultivation, climate change resilient building mechanisms are practices of yam farmers to reduce possible effects of climate change and to cope with the outcomes on yam production. The impact of climate change in the developing nations, according to Chukwuemeka *et al*. (2018), is mostly felt by the smallholder farmers, farmers that are highly dependent on rainwater and other climate-sensitive input and resources.

Majority of farmers in Nigeria depend on rain for growing crops. This is why the change in climate is so paramount and important for sufficient food production in the country. For instance, studies have revealed that change in weather conditions has affected food production in Nigeria through reduced crop yield which has the resulting impact on food security of the country in terms of affordability, availability, and per capital calorie food consumption (Izuogu *et al*., 2021; Adejuwon and Ogundiminegha, 2019).

Yam is an important food to the people of Nigeria as it serves several purposes. Yam can be eaten by man as food, used as feed for animals, and as raw material for industries (Okolo and Agu, 2013). Engagement in yam entrepreneurship ventures in any of the value chain has been proven as a tool to improved livelihood and reduces poverty (Komolafe, 2018). In the South-Western and Eastern regions of Nigeria, yam is one of the crucial items for tradition weeding. Many tribes across the West Africa countries have taken yam as one of their cultural heritage often used to perform sacrificial rites among the traditionalist (Ayanwuyi *et al*., 2011).

Climate change has been reported to affect yam production in Nigeria. Okongor *et al*. (2020) have affirmed that the variation temperature and sunshine have the tendency to influence yam yield. Therefore, farmers capability to manage with the effects of climate variability depend on factors like access to climate information and weather forecast, extension information on climate change, improved production technology, infrastructure, and management skill (Adeagbo *et al*., 2021). The need to generate more information about yam farmers' knowledge and needs on resilient strategies to mitigate climate variability is crucial to provide adaptation practices that meet their needs (Jan *et al*., 2021; Elijah *et al*., 2018). However, there is dearth of literature on the process of climate change adaptation decision making among yam farmers. Identifying the resilience building mechanism to adapt climate change in Benue State remains far from clear. Hence, this study was designed to make a contribution towards bridging the gap while the resilience mechanism adopted against these adverse climatic variables as well as the socioeconomic factors that predisposes the farmers to adopt those mechanism need detailed assessment. Thus, this study assessed the resilience building mechanism (RBM) used in mitigating the consequence of change in climate by yam farmers in Benue State, Nigeria. The specific objectives were to:

1. Assess resilience building mechanism used by farmers in mitigating the effects of climate change.
2. Identify the preferred resilience building mechanisms to mitigate the effects of climate change.
3. Ascertain main constraints in adjusting farming practices to changes in climatic conditions.

Materials and Methods

Study Area

This study was conducted in Oju Local Government Area (LGA) of Benue State, Nigeria. Benue state is

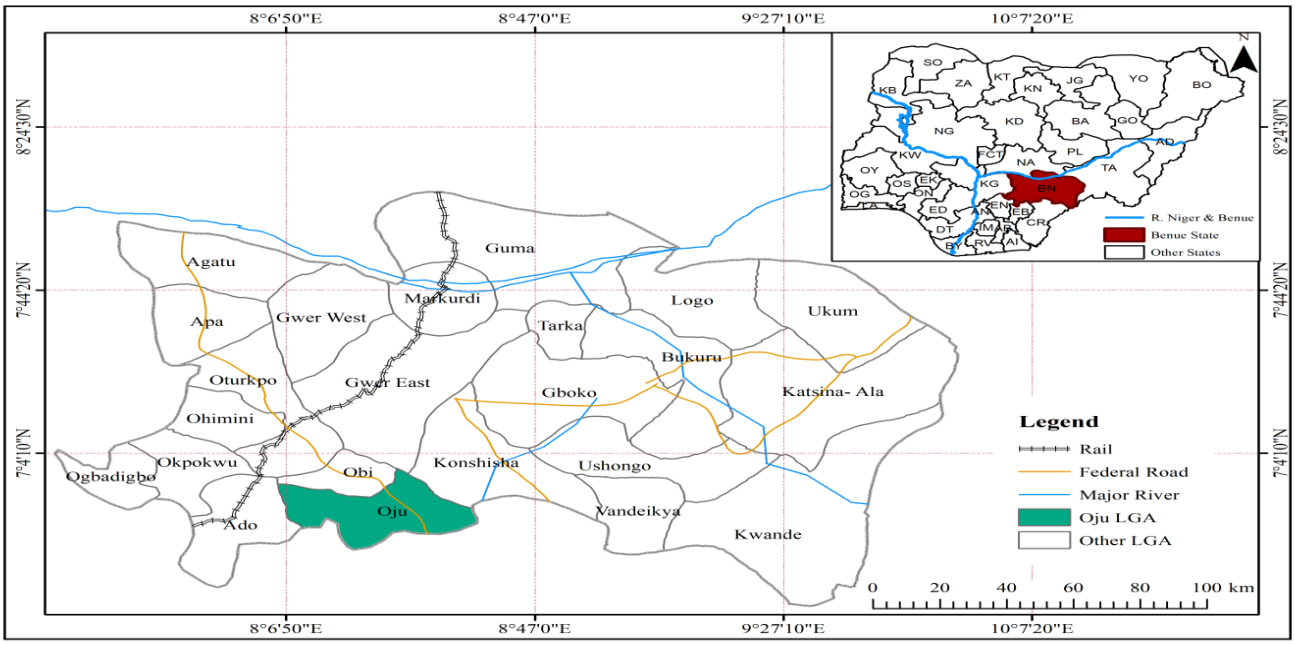

Figure 1: *Map of Benue State Showing Oju LGA.*

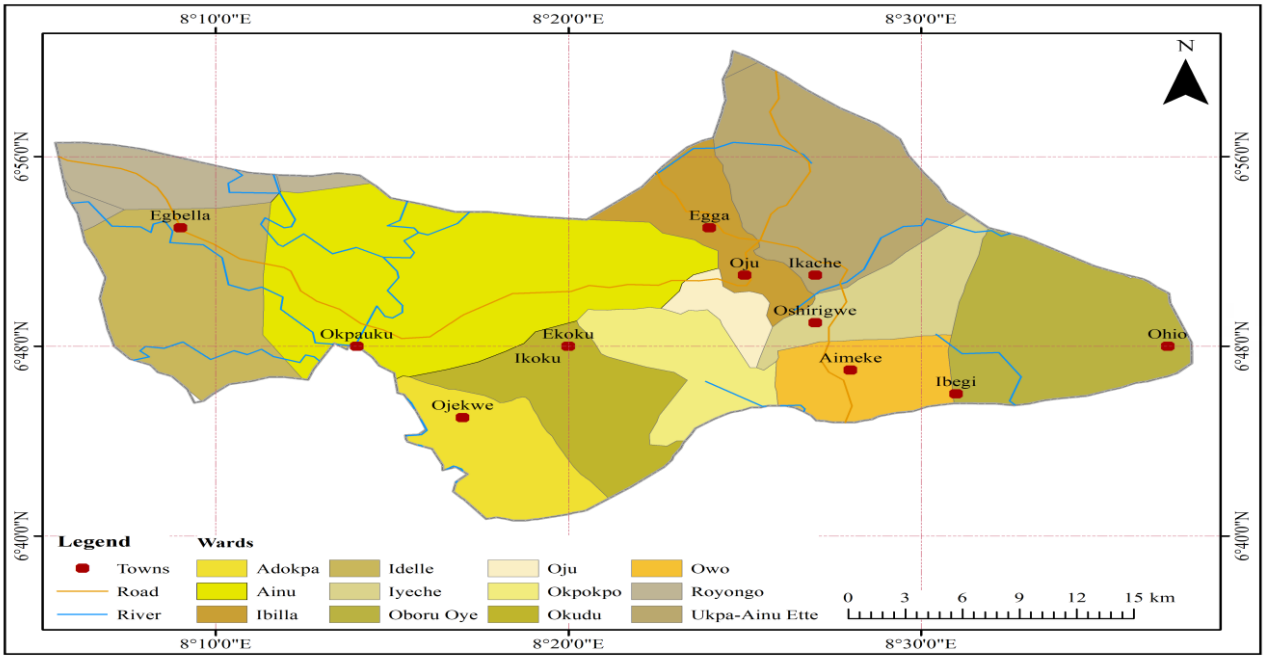

Figure 2: *Oju LGA Showing Selected Wards.*

popularly known to be called "the food basket of the nation". This may be attributed to abundant agricultural resources and land suitable for the production of yam, cassava, rice, cowpea, soya beans, amongst many others. Dry and raining seasons are the two different seasons that occur in the state. The raining season starts from April and end in October while the dry period commences in November and ends in March each year. The state is main located in the. The State is mainly situated in the savannah zone of Nigeria as its northern edge lies on the border of the Sahel and its southern side of the state lies on the border of the rain forest savannah zone of Nigeria. The state has the temperature ranging between 18°C to 37°C and rainfall of 1000-1500mm annually. The main ethnic groups in the state are Idoma, Tiv, Aakpa, Etulo, Igede, Jukun, Nyifon, Akwaye and Hausa. Benue state has a Guinea savannah kind of vegetation characterized with scattered trees and coarse grasses. Benue State has agricultural zones namely A, B, and C. The state is one of the highest yam growing states in Nigeria (Morse, 2020). (Figure 1 and 2).

Table 1: *Summary of sampling procedure and sample size.*

3-stage sampling	Population	Sampling procedure	Sample size
Stage 1	11 council wards in Oju LGA	Random selection of six council wards	6
Stage 2	55 communities in six council wards	Random selection of 3 farming communities	18
Stage 3	2,079 yam farmers in eighteen farming communities	Random selection of 10 yam farmers per community	180 yam farmers

Population and Sampling Procedure

Population of this study included all yam farmers in Oju LGA. A 3-stage sampling procedures was used to select respondents from the population. Firstly, six council wards out of eleven council wards in Oju L.G.A were randomly selected. Second stage involved a random selection of three (3) yam farming communities in the selected council wards making a total of eighteen (18) farming communities. Third stage involved a random of ten yam farmers in the selected farming communities to give a total of 180 sample size. Summary of the sampling is presented in Table 1.

Data Collection

An interview scheduled was designed to collect primary data for the study. Yam farmers were asked to indicate resilient building mechanisms used to adapt the effects of climate change on three point Likert-type scale (always used=3, sometimes used=2, never used=1). Based on experience on usage of the mechanisms, preference for the mechanisms was asked and measured on four point Likert-type scale (most prefer=3, prefer=2, least prefer=1, not prefer=0). Constraint to practicing the resilient building mechanisms was asked and measured on four point Likert-type scale (serious constraint=2, mild constraint=1, not a constraint=0).

Data Analysis

Descriptive statistics such as frequency count, percentage, mean and standard deviation were employed to analyse data collected. Also, multiple regression analysis (Ordinary Least Square) was performed to identify predictive socioeconomic factors that influenced the use of resilient building mechanisms to mitigate the effects of climate change. The Ordinary Least Square (OLS) model of regression was specified implicitly thus:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e_i \ldots\ldots (1)$$

Where:

Y: Resilient building mechanisms to mitigate effects of climate change; X_1: Age (years); X_2: Educational qualification (years of schooling); X_3: Farm size (acres); X_4: Farming experience (years); X_5: Membership of farmers' group (yes =1, no =0); β_0: Intercept; e_i: Error term.

Results and Discussion

Socio-economic Characteristics of the Yam Farmers

The socio-economic characteristics are crucial factors in the choice of agricultural practices of farmers. Studies have shown that social and economic status of farmers played critical roles in the practices to adapt the effects of climate change (Mogaka *et al*., 2021; Beyene *et al*., 2019). This study therefore described the socio-economic characteristics of yam farmers. Summary of the results is presented in Table 2.

The results presented in Table 2 showed the average age of the yam farmer was 45 years. This finding shows that the farmers are likely to be active and productive with possibility of high mental strength to ideas and circumstances of climate change. Further findings reveal that majority (83.3%) of the farmers were male. This implies that males dominate yam farming activities in the study area. Table 2 additionally showed that most 92.7% of the respondents were married and a fairly high household size of 10 people was found. This finding may positively influence the use of family labour for yam farming activities because of the intensive labour requirement to uptake some mitigation strategies against the unfavourable effects of weather variability in yam cultivation (Anozie *et al*., 2014).

As regards educational qualification of respondents, Table 2 reveals that 22.7% of the respondents have no formal education while others (77.3%) had formal education with either primary, secondary or tertiary education. This implies that appreciable number of the respondents were literate with the ability to read and comprehend simple posters or handbills on instructions to follow in minimizing the negative impact of Climate Change in yam farming. This find-

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ing is consistent with Aromolaran *et al*. (2017) who reported that attainment formal education can assist in scale up awareness and adoption of improved agricultural practices.

Table 2: *Socio-economic characteristics of respondents.*

Socio-economic characteristics	Mean	Frequency	Percentage
Age (Years)	45.37		
Farming Experience (Years)	22.8		
Size of farm land (Acres)	8.54		
Household size (persons)	9.73		
Estimated Annual income from Yam production (Naira)	134,047.30		
Gender			
Male		125	83.3
Female		25	16.7
Educational Qualification			
No formal		34	22.7
Primary		31	20.7
Secondary		54	36.0
Tertiary		31	20.7
Mode of farm land acquisition			
Purchase		27	18.0
Inherited		103	68.7
Leased/Rented		7	4.7
Gift		13	8.6
Membership of a group			
No		66	44.0
Yes		84	56.0
Source of Labor			
Hired		72	48.0
Self-effort		37	24.7
Family and Friends		23	15.3
Cooperative		14	9.3
Community		4	2.7
Contact with extension agent			
Yes		58	38.7
No		92	61.3

Source: *Field Survey, 2019.*

From the result in Table 2, it was indicated that the average size of yam farm cultivated was 8.54 acres. This finding affirmed that respondents were smallholder farmers. This report is in consonance with report by Ogbonna *et al*. (2011) that most farmers in Nigeria cultivate less than 1 hectare. This small size of farm size may facilitate the non-adoption of agricultural technologies that could help mitigate climate change, because adoption is a often promoted by availability of large farm size and this could hampered yam farmers from building sustainable resilience on the longer term. Despite the smallness of their farm size, majority 68.7% of the respondents acquired their farmland by inheritance. This implies a nature of permanent land holding that is expected to encourage farmers in building resilience on a long term basis to minimize the outcomes of the effects Climate Change in yam farming.

The results of data analysis presented in Table 1 further shows that the average farmers' farming experience was 23 years and their average annual returns was 134,047.30 Naira. This finding is an indication that the respondents had long years of experience in yam cultivation. This study suggests that the appreciable years of respondents' participation in yam farming is expected to result in some knowledge and skills in building resilience to changes in climate effects in the business of yam production. This is consistent with Ofuoku (2011) who reported that a well experienced farmer will have a better understanding of climatic indicators and their advert effects to agricultural yield. The result of table 1 above indicated that higher proportion 61.3% of the yam farmers had no contact with an extension agent. The likelihood of adopting Climate Change resilience building mechanism may decreases with farmers' decrease in contact with to extension agent.

Use of Resilience Building Mechanisms to Mitigate Effects of Climate Change by Yam Farmers

Like other food production system, yam cultivation is prone to the adverse impact of climate change (FAO, 2019). This is because production in Nigeria mainly depends on rainwater. Farmers have however devised some resilient building mechanisms to minimize the effects of climate change. This study therefore examined some of the practices employed by yam farmers. Summary of the result is presented in Table 3.

It was reveals that the yam farmers in Oju LGA use all the resilience building presented in this study to reduce the outcomes of Climate Change except for weather forecast (Mean=1.42) and Change in farming type (crop-livestock) (Mean= 1.36) which is below the mean score of 1.49. Hence only weather forecast and Change in farming type (crop-livestock) are not commonly used as a resilience building mechanism by the yam farmers of Oju LGA.

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Table 3: *Percentage distribution of respondents based on usage of resilient building mechanisms to mitigate effects of climate change.*

Resilience Building Mechanism	AU	SU	NU	Mean
Use of mulching	6.0	45.3	48.7	2.43
The use of organic fertilizer/ farmyard manure	18.7	35.3	46.0	2.27
Crop rotation	20.0	35.3	44.7	2.25
Planting of early maturing yam seed	2.7	10.0	87.3	2.85
Planting of cover crops	19.3	42.0	38.7	2.19
Change in planting date	12.0	62.7	25.3	2.13
Change in harvesting date	28.7	47.3	24.0	1.95
Adaptation of new technologies (Yam minisett)	59.3	29.3	11.3	1.52
Mixed farming practice	56.0	18.0	26.0	1.70
Lengthened fallow	13.3	48.7	38.0	2.25
Use of weather forecast	73.3	11.3	15.3	1.42
Diversification into non-farm activities	28.0	31.3	40.7	2.13
Planting of trees	28.0	39.3	32.7	2.05
Integrated insect pest/ diseases management	29.3	52.0	18.7	1.89
Crop diversification	11.3	28.0	60.7	2.49
Soil and water conservation techniques	52.0	42.7	5.3	1.53
Engaging in alternative farming type (crop-livestock)	74.7	14.7	10.7	1.36
Change in construction of storage facilities	38.0	45.3	16.7	1.79
Variation in indigenous pattern of weather	48.0	32.7	19.3	1.71

AU=Always Used, SU=Sometimes Used, NU=Never Used

Preferred Resilience Mechanism for reducing the effects of Climate Change

It is expected that experience of resilience building mechanisms used to mitigate the effects of Climate Change by the yam farmers would have taught them the effective mechanisms and then preferred practices among other options. This study investigated the preferred resilience building mechanisms to mitigate the effects of Climate Change. Summary of the results is presented in Table 4.

Respondents' preferred resilience mechanism to reduce the effects of Climate Change is presented in Table 4. It was determined in the table that the yam farmers mostly preferred to Plant early maturing yam seed (M= 3.58), while they preferred to use mulching (M= 3.46), Crop rotation M= 3.27), Organic fertilizer or Farmyard Manure (M= 3.07), Plant cover crops (M= 3.05), while they least prefer to use weather forecast (M= 2.45), and Mixed Farming Practices (M= 2.13).

Constraints to Practicing the Resilient Building Mechanisms

This study investigated the constraints yam farmers faced in practicing the resilient building mechanisms to mitigate the effects of climate change. Result of analysis of data collected on constraints is presented in Table 5.

Findings in Table 5 shows the distribution of the respondents based on the constraints encountered in practicing the resilient building mechanism to minimize the negative outcomes of Climate Change. Findings showed that inadequate access to improved technologies (89.3%), inadequate finance (86.0%) and insufficient information on weather incidence (84.7%) were the leading serious constraints faced by most farmers in in practicing the RBM. This finding is consistent with Abraham and Fonta (2018) who found that most of the farmers in Northern Nigeria have experienced the climate change effects, but are incapacitated to mitigate the effects due to lack of access to credit. Majority of the sampled yam farmers furthers indicated inadequate extension services and education (78.7%), indigenous practices (66.0%) and traditional belief (63.3%) as serious constraints in adjusting yam farming practices to changes in weather condition. One of the functions of agricultural extension agents is to change the attitude from traditional system of farming to new practices for improved production, but this case where there is report of inadequate access to new technologies which may be connected to inadequate extension services, farmers are much likely to hold on to indigenous practices and some traditional belief which may not effectively mitigate the climatic condition for improved yam production in the study area (Izuogu *et al.*, 2021; FAO, 2016).

Other notable constraints are scarcity of organic fertilizer, inadequate knowledge on resilience building mechanism option, nature of land ownership, shortage of labor, poor potential for irrigation, disease outbreak, inadequate storage facilities, lack of capacity building were revealed as mild constraints to practicing RBM for reduce the effects of climate changes in the study area.

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Table 4: *Percentage distribution of respondents' based on their preferred resilience mechanism for reducing the effects of climate change.*

Resilience Building Mechanism	Most prefer (%)	Prefer (%)	Least prefer (%)	Not prefer (%)	Mean	Rating
Use of mulching	55.3	38.0	4.0	2.7	3.46	2nd
The use of organic fertilizer	44.7	30.7	12.0	12.7	3.07	4th
Crop rotation	40.7	48.7	7.3	3.3	3.27	3rd
Planting of early maturing yam seed	64.7	30.0	4.0	1.3	3.58	1st
Planting of cover crops	35.3	39.3	20.7	4.7	3.05	5th
Change in planting date	22.7	46.7	23.3	7.3	2.85	7th
Change in harvesting date	18.0	35.3	33.3	13.3	2.58	10th
Yam mini sett technology	28.7	25.3	19.3	26.7	2.56	11th
Mixed farming practices	19.3	19.3	16.0	45.3	2.13	13th
Lengthened fallow	38.0	24.7	15.3	22.0	2.79	8th
Use of weather forecast	22.0	30.0	18.7	29.3	2.45	12th
Diversification into non-farm activities	32.7	34.0	19.3	14.0	2.85	6th
Planting of trees	32.7	22.7	25.3	19.3	2.69	9th

Source: *Field Survey, 2019.*

Table 5: *Constraints to practicing the resilient building mechanisms to mitigate effects of climate change by yam farmer.*

Constraints	Serious (%)	Mild (%)	No (%)	Mean
Traditional belief	63.3	22.7	14.0	2.49
Inadequate finance	86.0	11.3	2.7	2.83
Inadequate access to new technologies	89.3	10.0	0.7	2.89
Insufficient information on weather incidence	84.7	14.0	1.3	2.83
Inadequate knowledge on resilience building mechanism	58.0	27.3	14.7	2.43
Inadequate extension services and education	78.7	15.3	6.0	2.73
Nature of land ownership	44.7	20.7	34.7	2.10
Shortage of labour	30.0	23.3	46.7	1.83
Poor potential for irrigation	34.7	50.7	14.7	2.20
Disease outbreak	40.7	50.7	8.7	2.32
Scarcity of organic fertilizer	58.7	36.0	5.3	2.53
Inadequate storage facilities	48.0	32.0	20.0	2.28
Lack of capacity building	40.7	47.3	12.0	2.29
Indigenous practices	66.7	21.3	12.0	2.55

Source: *Field survey, 2019.*

The result of Table 6 shows that only the farm size (p= 0.017, t= 2.421) and membership to a group (p=0.013, t= 2.527) of the respondents had positive significant relationship with the preferred Resilience Building Mechanisms used in minimizing to the consequences of Climate Change in yam farming in Benue State. This finding implies that the larger the size of farms, the more the number of resilience building mechanism adopted by the farmers. The results also implies that membership of group will give yam farmers a forum where they b the opportunity to access credit loan and information to enhance their capacity to mitigate the influence of climate change on yam farming.

Conclusions and Recommendations

Yam farmers in Oju LGA are literate with long years of yam farming experience but low contact with agricultural extension agents. The leading RBM com-

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monly employed and preferred by yam farmers are planting of early maturing yam seed, crop diversification, use of mulching and crop rotation practices. The main serious constraints faced by most farmers in in practicing the RBM are inadequate access to improved technologies, inadequate finance and insufficient information on weather incidence. Education and membership of group are determinant factors for use of resilient building mechanism in reducing the damages climate change could cause yam growth and yield.

Table 6: *Multiple regression results on factors influencing usage of resilient building mechanisms to mitigate effects of climate change by yam farmers.*

Model	Coefficient	Std. Error	t	p-value
Age	.004	.005	.753	0.453
Education Qualification	.063	.039	1.615	0.108
Farm size	.013*	.005	2.421	0.017
Farming experience	-.009	.005	1.698	0.092
Membership to a group	-.213*	.084	2.527	0.013
R Square = 0.590 = 59.0%				
Adjusted R-Square = 0.106				

As a result of findings in this study, there is need for government in collaboration with development agencies to intensify efforts in the awareness and improving of farmers' knowledge on the various means of building resilience to mitigate the menace of adverse effects of Climate Change. Government should revitalize meteorological station and extend its services to rural areas. Also in designing programmes and policies on Climate Change effects, the government and Non-governmental organizations should be prioritized to accommodate farmers with different age limits and finally cooperatives organizations should be the first point of call since membership of the cooperatives enhanced information sharing on modern farming techniques and exchange of best agronomical best practices.

Novelty Statement

We (authors) are reporting, for the first time, the resilience building mechanism to mitigate effects of climate change, specifically among yam farmers in Benue State, Nigeria. A regression model developed to predict factors was applied to identify factors influencing usage of resilient building mechanisms to mitigate effects of climate change by yam farmers.

Author's Contribution

Olufemi Bolarin: Conceptualization of research work, execution of field and data collection and analysis of data and interpretation.
Sijuade Adebukola Adebayo: Execution of field and data collection.
Sola Emmanuel Komolafe: Analysis of data and interpretation and reparation of manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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