Continental J. Applied Sciences
Adejo et al. (2024) 19 (2): 35 – 50 Doi: 10.5281/zenodo.13239792

Research Article

Factors Influencing Choice of Adaptation Strategies to Climate Change by Yam Farmers in Nasarawa State, Nigeria

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Abstract

This study seeks to determine factors influencing choice of adaptation strategies to climate change by yam farmers in Nasarawa state, Nigeria while the specific objectives were to examine the socio-economic characteristics of the respondents in Nasarawa states, Nigeria; identify factors influencing the choice of adaptation strategies by respondents in the study area; examine constraints to yam farming in the study area. Descriptive statistics, Multinomial Logistic Regression (MNL) and the Relative Importance Index (RII) were used to analyse the objectives. The study revealed a mean age of 51years and a mean yam farming experience of 37years. Respondents are literate and fertilizer is the major input for Yam production the study area. Yearly income, years of formal education, Household size and Educational level were the major factors influencing choice of adaptation strategies while Different planting dates (DPD), Cover cropping and Use of Inorganic fertilizers (UIF) were the major adaptation techniques been practiced. A Relative Importance Index of 0.78, 0.60, 0.55 and 0.58 indicates the major constraints to yam farming as Encroachment by Herders, Inadequate land, High cost of input and Changes in weather respectively. The study recommended that Government at all levels should be proactive in implementing the 1978 Land Use Act of Nigeria and Ranches for herders. This will provide adequate agricultural land for farmers as they desire to increase production but are constrained by the problem of inadequate land due to fragmentation and displacement due to Farmers/Herders crises. Also, adequate capacity building which will improve the farmers' knowledge of appropriate mitigation strategy should be provided in order to mitigate the deleterious climate change effect experienced in their communities.

ISSN: 3043-6087. Science and Education Development Inst., Nigeria

Keywords: Adaptation strategies, Relative Importance, Constraints, Climate Change and Factors

Received: 12 May 2024 **Accepted: 30 July 2024**

Citation: Adejo, S. A., Amos, T. T. and Awolala, D. O (2024). Factors Influencing Choice of Adaptation Strategies to Climate Change by Yam Farmers in Nasarawa State, Nigeria. Continental J. Applied Science, 19(2), 35–50. Doi: 10.5281/zenodo.13239792

Introduction

Yam yield has been relatively low in Nigeria compared to other West African countries; 9.55t/ha in Nigeria, 10.83t/ha in Cote'Ivoire, 10.94t/ha in Benin and 12.74t/ha in Ghana and currently, Nigeria and Côte d'Ivoire produce at average yields of 17.3 and 12.5%, respectively, of the estimated potential yam production (50t/ha), exhibiting the lowest yam productivity over the decade. (Bassey 2017; Owusu, et. al. 2022).

Even though Nigeria is the largest yam producer in the world, yam exports has remained low (Bergh *et al*, 2019). Nwosu and Okoli (2010) has noted that the increase in yam output has been largely due to cultivation of more land area rather increase in Yam productivity. This is the reason why the International Institute of Tropical Agriculture (2009) stated that there has been a decline in yam yield in Nigeria over the years. The average yield per hectare has drastically reduced from 14.9% in 1986 – 1990 to 2.5% in 1996 – 1999 (CBN, 2002; Adegbite *et al*; FAO, 2007) and this has continued to decline till date. Yam production in Nigeria is vulnerable to the effects of climate change and variability. This manifests through its negative impacts on crop growth and yield (Elijah *et al*., 2018). Similarly, Nwosu and Okoli (2010) noted that despite the fact that yam thrives and produces well in Nigeria, it has depicted different growth rates and fluctuating yields in different years due to differences in the annual weather condition.

Yam is one of the major cash crops and most consumed food crop in West African countries like Nigeria (Babaleye, 2003; NBS, 2012). As a potential source of foreign exchange, this study will help investors, NGOs, relevant government agencies and other agricultural industries understand the potentials that abound within the yam sector prompting investments to tap into huge markets and earn foreign exchange for the country and improve the country's Gross Domestic Product. Subsequently, improvement

ISSN: 3043-6087. Science and Education Development Inst., Nigeria

in yam production through climate change adaptation studies will provide adequate and timely supply of raw materials to agriculturally based processing industries.

Nigeria being the largest producer of yam in the world makes this study very imperative to deepen understanding on ways of improving productivity of yam in the face of deleterious effects of climate change to make it a crop that could become a foreign exchange spinner for the country. Despite these assertions, the Adaptive strategies of yam farmers in Nassarawa State have not been critically examined. Nigeria's Yam related researchers have focused on awareness, perception to climate change; problems, prospects and challenges to yam production; and impact and effects of climate change, climate variability on yam production (Sunday and Nancy, 2021; Oluwatayo, 2016; Nnadi, Liwenga, Lyimo, and Madukwe, 2019; Dada, Usman, Samaila and Ishaya, 2021; Bassey, 2017; Chidozie, 2017; Zakari, Muhamed, Medugu and Sandra, 2014; Okongor, Njoku, Essoka, Efiong, 2021; Olorunlana and Folasade, 2018).

There is an urgent need to ascertain the adaptation strategies of yam farmers to climate change in this study area with a view of understanding factors responsible for the choice of the various adaptive strategies employed. In respect to the above, this study seeks to achieve the following objectives:

i. examine the socio-economic characteristics of the respondents in Nasarawa State, Nigeria
ii. identify factors influencing the choice of adaptation strategies by respondents in the study area
iii. examine constraints to yam production in the study area.

Materials and methods

Methodology

Study Area

The study was carried out in Nasarawa States, Nigeria. It lies in the middle belt of the country. Nasarawa state is located between latitude 7^0 45' and 9^0 25' N of the equator and longitude 7^0 9^0 36 E of the Greenwich meridian with a population of 1, 869,377(2006 population census) and a total land area of 27,117km^2 (10,470sq/ml). Nasarawa state is bounded in the North by Kaduna state, in the west by Federal Capital Territory, in the south by states of Kogi and Benue and in the east by Taraba and Plateau. Nasarawa States are made up of 13 local government areas (LGAs).

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The average yearly rainfall in Nasarawa state is 1311.75 cm, with average temperatures ranging from 25^0c in October to roughly 36^0c in March (Nigerian meteorological Agency, Lafia 2012). With two distinct wet and dry seasons, the state experiences a tropical climate. The state typically experiences six months of rainy and six months of dry weather. The rainy season runs from April to September, while the dry season, which features savannah vegetation, lasts from October to March.

Method of Data Collection

Data for the study was collected from both primary sources. Primary data was collected through the use of a well-structured questionnaire to elicit data on the socio-economic characteristics of the yam farmers in the study area, as well as factors that predisposes these farmers to the deleterious effects of climate change and the adaptive strategies used to mitigate these changes.

Sample and Sampling Technique

A multi stage sampling procedure was for this study.

1) The first stage was the purposive selection of one agro ecological zone from the state. This selection was based on the level of yam production within the various agro ecological zone.
2) The second stage was a purposive selection of two Local Government Areas each from the total Local Government Areas within the agro ecological zone based on the level of yam production. This was based on the data on number of Yam farmers and Quantity of yam production from these local governments as obtained from NADP.
3) The third stage was a random selection of four communities each from the two Local Government Areas. This will bring the total number of communities to eight. These was done the assistance of the Extension units of NADP.
4) The last stage was a random selection of twenty-three farming households from each community. This brought the total number of respondents to one hundred and eighty-four but only one hundred and eighty questionnaires were accounted for. This was made possible through the sample frame obtained the Department of Extension at the various local government.

   The structured questionnaires were administered through personal interviews and group focused discussions (FGD) at the various communities.

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Analytical Technique

Multinomial Logit Model (MNL) for Adaptation Strategies

The Multinomial Logit Model was employed in the study to examine the factors affecting choices of adaptation strategies (objective ii). It was corroborated by Apata (2011) who stated that Multinomial Logit (MNL) and Multinomial Probit (MNP) models are the common analytical approaches that are commonly used in an adoption decision and also appropriate for evaluating alternative combinations of adaptation strategies, including individual strategies.

Multinomial Logit (MNL) was employed to examine factors that influence the choice of adaptation strategies used by yam farmers in Nasarawa State. This study will employ the standard Multinomial Model, the probability function which was defined by Maddala (2001). It is a generalization of the logistic regression model for cases where there are more than two outcomes, and where the outcomes are not ordered. The MNL model is used widely in econometrics to explain the choice of an alternative among sets of exclusive alternatives.

Let Y_1 be a random variable representing the adaptation measure options chosen by any farming household taking on the value (1, 2 ….J) for J, a positive integer, and Let X represents a set of set of conditioning variables which represent household attributes/socioeconomic characteristics.

The question is how ceteris paribus changes in the elements of X affect the response probabilities

$$P(Y = j/X), \text{j} = 1, 2 \ldots..\text{J} \qquad (1)$$

Since the probabilities must sum up to unity, $P(Y = j/X)$ is determined once we know the probabilities for j = 2 … J

Let X be a 1 x K vector with first element unit

The MNL model has response probabilities.

$$P(Y = j/X) = \exp(X\beta j)/\{1 + \sum_{h=1}^{j} exp(X\beta h), \text{j} = 1, \ldots.\text{j}\} \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

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According to Fatuase and Ajibefun (2014), unbiased and consistent parameter estimates of the MNL model in equation (1) requires the assumption of independence of irrelevant alternatives (IIA) to hold which means that the probability of using a certain adaptation measure by a given household needs to be independent from the probability of choosing another adaptation measure (i.e Pj/Pk is independent of the remaining probabilities). The premise of the HA assumption is the independent and homoscedastic disturbance terms of the basic model in equation (2).

The parameter estimates of the MNL model provides only the direction of the effect of the independent variables on the dependent (response) variables, but estimates do not represent either the actual magnitude of change nor probabilities (Fatuase and Ajibefun, 2014). Differentiating equation (18) with respect to the explanatory variables provides marginal effects of the explanatory variables given as;

$$\frac{\sigma Pj}{\sigma Xk} = P_j(\beta_{jk} - \sum_{j=k}^{j-1} Pj\beta jk) \quad \text{.....(3)}$$

the marginal effects or marginal probabilities are functions of the probability itself and measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean (Green, 2000; Koch, 2007; Deressa *et al*., 2008; Fatuase and Ajibefun, 2014).

The explicit function of the MNL model is given below:

$$Y^* = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 \text{.....} + \beta_nX_n + e_1 \text{.....} \quad (4)$$

Where:
Y* = dependent variables (Adaptation measures option) which are:
1 = Different Planning Dates (DPD)
2 = Practicing Crop Diversification (PCD)
3 = Practicing Mixed Cropping (MC)
4 = Use of Organic Fertilizers (UOF)
5 = Use of Inorganic Agro Chemicals (UAC)
6 = Use of Improved Varieties (UIV)
7 = Use of Irrigation Systems (UIS)
8 = Land fragmentation (LF)
9 = Use of alternative fallow practices (UAF)

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10 = Mulching (M)
11 = Cover Cropping (CC)
12 = Planting of trees (PT)
13 = Use of Weather Forecast (UWF)

While; the X's are the explanatory variables, which are:
X_1 = Age of Respondent (Years)
X_2 = Gender of household head (dummy:1 = Male and 0 = female)
X_3 = Farming Experience (Years)
X_4 = Yam Farming Experience (Years)
X_5= Marital Status (dummy:1 = single, 2 = married, 3 = widowed, 4 = divorced and 5 = separated)
X_6 = Educational level of household head (years spent in school)
X_7 = Years of Formal Education (Years)
X_8 = Household Size (Number)
X_9 = Farm Size (ha)
X_{10} = Yearly Income (Naira)
X_{11} = Average Income from other Sources (Naira)

Relative Importance Index (RII)
The relative Importance Index was used to examine the constraints to yam production in the study area. Descriptive statistics such as frequencies and percentages were used to identify the problems while four-point Likert type rating scale (LRS) will be used to explain how serious the problems are to the farmers. The last step was the use of RII to determine the problems that need serious urgent stakeholders' interventions. The advantage of RII is that the method helps to determine the importance of factors relative to others. It was used to determine the most preferred factor or option based on the response of the respondents.

The four-point rating scale (Not all = 1, Mild = 2, Serious = 3, and Very Serious = 4) will be adopted and transformed to relative importance indices (RII) for each of the constraints experienced by yam farmers in the study area.

The equation is given below:

$$RII = \sum \frac{W}{AxN} \quad \text{...} (5)$$

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Where W is the weight given to each problem by the respondents (1 to 4); A is the height weight (4 in this case); N is the total number of respondents. Therefore, RII value ranges from 0 – 1 (0 not included). The higher the value of RII, the more important the factor (problem) to the respondents in the study area as stated by Oseni (2017).

Results and Discussion

Socio economic characteristics of Respondents

The distribution of Respondents according to age of yam farmers in Nasarawa States shows that majority (64.23%) of respondents in Nasarawa State are within their active productive age with a mean age of 56.86 years and a standard deviation 11.98 years. This finding agrees with Ariyo *et al* (2020) who opined that yam farming requires energy and hence yam farmers should be within their active age for active production.

The result equally reveals a low participation of the youth, which should not be unconnected to the migration of youth to urban centers due to the fact that being educated places them in an advantaged position to secure white collar jobs and hence tends to evade drudgery associated with Yam production and farming in general.

A close observation of the result also reveals that majority (93.36%) of Farmers in Nasarawa state possess a Yam farming experience of more than 10years. The Farmers could thus be assumed to have very good and practical experience of yam farming hence will be well abreast with various conservation strategies to conserve soil nutrient and minimize adverse effect. This is in agreement with Cheteni and Umejesi (2023) who observed that farmers were familiar with sustainable farming practice and they practiced these strategies to boost yields.

It Further reveals that majority of the farmers are 87.78% literate. This implies that farmers in Nasarawa state are literate and will be receptive to adopting mitigation strategies against climate change as well as understanding various innovations to mitigate these changes. Since the respondents are educated, they will be better prepared to overcome shocks associated with the deleterious effects of climate change on yam production in the study area. This finding is in support of Anabaraonye *et al.* (2018) who quoted UNESCO, (2010) revealed that education is a crucial aspect of global response to climate change. He noted that it helps educated people to grasp, understand and address

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the impact of global warming as well as encourage changes in their attitudes and behaviors while helping them adapt to climate change related trends.

Table 1: Socio economic characteristics of Respondents

Socio economic Characteristics	Frequency	Percentage
Age		
≤ 30	2	1.1
31-40	34	18.91
41-50	65	36.1
51-60	44	24.46
≥ 61	35	19.46
Mean	51.83	
Std Dev	11.99	
Yam Farming Experience		
≤10	18	10
11-20	37	20.57
21-30	46	25.57
31-40	45	25.01
≥41	34	18.9
Mean	37.37	
Level of Education		
No Formal Education	26	14.44
Primary School Education	51	28.33
Secondary School Education	76	42.22
Tertiary Education	27	15.00
Input Used		
Fertilizer	163	90.56
Herbicides	16	8.89
Pesticides	1	0.56
Manure	0	0

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The result of the mode of land acquisition for yam farming among respondents in the study area, revealed that majority (83.89%) of respondents in obtained their land through inheritance while the least utilized mode of land ownership was lease. This could be due to the fact that lease is not readily established in terms of agricultural resources in Nigeria. Also, majority of the land tenure system been practiced in Nigeria's rural areas despite the land tenure law of 1976 remains the traditional land ownership structure. This with its challenges has mostly led to fragmentation of land and disputes within communities. inheritance.

Result of Adaptation to Climate Change by Respondents in Nasarawa State

The result of Multinomial logistic regression for Adaptation strategies to climate change by yam farmers in Nasarawa state is presented in Table 2. The result revealed a positively statistically significant relationship between Educational level and practice of cover cropping with a coefficient of 7.269 at 5% level of significance. Hence an increase in educational level by 1 year, increases the practice of cover cropping by 7.269 units. Cover cropping has the ability to control weed, reduce cost of manual labour and over reliance on Herbicides (Tworkoski, and Glenn 2012). This implies that these farmers by virtue of their education are aware of this fact and tends to tap into the potentials of this as an adaptation strategy to cushion the deleterious effect of climate change in Nasarawa Sate. Similarly, a positively statistically significant relationship was found between years of formal education and DPD at 5% with a coefficient of 0.492years, which implies that an increase in the years of education by one year leads to 0.492 unit increase in DPD as a strategy to mitigate the effect of climate change in the study area. This is in consonance with Ogunjimi and Ikefusi (2021) who noted that Different planting dates (DPD) was an adaptation strategy used by yam farmers in Kogi State. It is further revealed that a negative but statistically significant relationship exist between Age and POT at 10% significance level and coefficient of -0.19l which implies that an increase a unit increase in age results in -0.191 decrease in POT. This is not unconnected with the fact that Nigerians hardly plant trees especially as it concerns an adaptation strategy to mitigate climate change since these trees often prevent sunlight from reaching the plant and hence impede growth of the crop. Therefore, older farmers tend to understand that yam is not a shade loving plant and therefore desist from planting trees around the farm and equally tend to trim overgrown trees casting shadow on the yam farm.

Similarly, a negative relationship has also been detected between marital status with a coefficient of -2.673 and planting of trees (POT), Household size with a coefficient of -0.635 and planting of trees (POT) all significant at 10% which implies that planting of

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trees (POT) is not an adaptation strategy welcomed in this study area and this still points to the fact that yam is not a shade loving plant. This finding buttresses the earlier assertion that Tree planting is not a good adaptation strategy for climate change among yam farmers therefore the prominence of negative relationship between these socioeconomic characteristics and Planting of Trees (POT).

Years of formal education is found to have a positively relationship with cover cropping with a coefficient of 1.326 but statistically significant at 5%. Which implies a unit increase in years of formal education results in 1.326 increase in the practice of cover cropping. This cannot be unconnected with the fact that cover cropping reduces cost expended on manual labour and Herbicide cost which increases the total cost of production of yam.

Constraints to Yam production in Nasarawa State

The result of constraints to Yam production in Nasarawa state is presented in Table 3. The challenges were presented on a Likert scale after which the various indices were calculated based on their relative priority. The most serious constraint experienced by yam farmers in Nasarawa state was encroachment by herders (1st). This has been a major challenge in these yam production communities. Cattles often destroy crops while grazing on the field which has generated much crises between the farmers and the herders.

High cost of Inputs which can be attributed to general inflation of good and services in Nigeria was the third (3^{rd}) major constraint of yam farmers in Nasarawa state while Changes in weather happens to be the 4^{th} major constraints experienced by Yam farmers in the study area. This implies that fluctuations in weather was impeding the production of yam in Nasarawa state. This was glaring in the trend of Rainfall possessing volatile fluctuations.

The least constraints experienced by farmers in Nasarawa state were Traditional Barrier or Belief system (16^{th}) and Destruction of Yam farm by wild fire (17^{th}). Yam being a staple food by Nigeria has no Traditional barriers and in fact it is a requirement in most cultural and traditional ceremonies also, wild fire were not prevalent in Nasarawa state.

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Table 2: Distribution of Nasarawa State Yam Farmer by Adaptation Strategies in Nasarawa State

Independent Variables	DPD	PCD	UOF	UIF	UIV	UAF	MULCHING	COVER CROPING	POT
Age	-0.216 (0.816)	0.001 (0.989)	0.053 (0.61)	-0.009 (0.931)	0.010 (0.944)	-0.225 (0.808)	-4.088 (0.99)	0.063 (0.591)	-0.191* (0.08)
Sex	1.064 (0.401)	-15.373 (0.992)	-16. 488 (0.998)	-15.436 (0.992)	15.962 (0.993)	8.298 (0.893)	67.525 (0.999)	-1.424 (0.314)	1.029 (0.392)
Farming experience	0.862 (0.309)	-0.007 (0.934)	-0.065 (0.464)	-0.047 (0.605)	-0.231 (0.167)	0.957 (0.34)	-1.393 (I)	-0.001 (0.987)	0.152 0.113
Yam farming experience	0.028 (0.474)	-0.005 (0.899)	0.069 (0.138)	0.019 (0.695)	0.193 (0.095)	0.444 (0.755)	-0.404 (I)	0.099 (0.125)	0.043 (0.289)
Marital status	-0.531 (0.699)	-31.085 -0.991	19.628 (0.996)	-2.780* (0.09)	0.092 (0.95)	9.601 0.764	-81.606 (0.998)	-1.776 (0.219)	-2.673* 0.076
Educational level	-1.455 (0.267)	0.044 (0.803)	4.414 (0.021)	2.268 (0.189)	1.319 0.408	-0.158 (0.915)	-118.567 (0.996)	7.269** (0.037)	1.685 (0.334)
Years of formal education	0.492** (0.024)	0.044 (0.803)	-0.501 (0.048)	-0.321 (0.176)	-0.360 (0.147)	1.386 (0.609)	15.474 (0.996)	1.326** (0.024)	-0.331 (0.198)
Householdsize	-0.125 (0.603)	0.268 (0.351)	0.093 (0.739)	-0.343 (0.214)	-0.173 (0.613)	-4.893 0.282	2.43 0.999	-1.101*** (0.009)	-0.635* (0.064)
Size of yam farm	-1.120 (-0.041)	-3.764 (0.396)	0.409 (0.39)	0.507 (0 354)	0.829 (0.179)	-8.052 (0.48)	15.342 (0.999)	-0.244 (0.754)	-0.413 (0.382)
Yearly income	4.160** (0.01)	1.560 (0.212)	2.720 (0.758)	1.330 (0.735)	-3.330 (0.947)	0.000 (0.258)	0.000 (0.999)	6.520** (0.018)	2.020 (0.225)
Average yearly Income from Other sources	-3.570 (0.034)	-5.690 (0.748)	3.530 -0.118	2.690 (0.16)	1.780 (0.382)	0.000 (0.363)	0.000 0.996	-3.170 (0.123)	-2.28 (0.193)

*, ** and *** for 10%, 5% and 1% respectively

Source: Field Survey, 2023

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Table 3: Result of Constraints to Yam Production in Nasarawa State

	Nasarawa State					
Constraint	**Very Serious (%)**	**Serious (%)**	**Mild (%)**	**Not a Constraint (%)**	**RII**	**Rank**
Encroachment by Herders	92.78	5.00	1.66	0.56	0.78	1st
Inadequate Land	3.89	73.89	11.66	0.56	0.60	2nd
High Cost of input	6.67	83.36	9.44	0.56	0.59	3rd
Changes in Weather	2.78	87.22	8.89	1.12	0.58	4th
Lack of Credit Facilities	1.67	86.11	11.66	0.56	0.58	4th
Inaccessibility of Roads	5.00	80.56	12.22	2.22	0.58	4th
Lack of Access to Information	1.67	86.11	11.66	0.56	0.58	4th
Scarcity of Labour	6.11	77.22	8.89	7.78	0.56	8th
Lack of Market	5.00	71.11	22.78	1.11	0.56	8th
Land fragmentation	0.00	78.89	21.11	0.00	0.56	8th
Lack of Knowledge on Climate	3.33	63.33	33.33	0.00	0.54	11th
High illiteracy level	2.22	67.78	30.00	0.00	0.54	11th
Non availability of implements and inputs	3.33	67.78	28.89	0.00	0.54	11th
Destruction in quality of produce	0.00	56.11	43.89	0.00	0.51	14th
Destruction by flood	1.11	38.33	57.78	2.78	0.47	15th
Traditional Barriers or Belief system	0.5	28.33	68.89	2.22	0.45	16th
Destruction by Bush fire	1.11	19.44	78.33	1.11	0.44	17th

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Conclusions

The result concluded that majority of farmers are male, married and within an active age. Years of farming experience, education level and years of formal education are the major determinants of choice of adaptation strategies for Nasarawa State.

Recommendations

Education was found to significantly increase the practice of mitigation strategies hence; Also, adequate capacity building which will improve the farmers knowledge of appropriate mitigation strategy should be provided in order to mitigate the deleterious climate change effect experienced in their communities. Government at all levels should be proactive in implementing the 1978 Land Use Act of Nigeria and Ranches for herders. This will provide adequate agricultural land for farmers as they desire to increase production but are constrained by the problem of inadequate land due to fragmentation and displacement due to Farmers/Herders crises.

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