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# Determinants for Adopting Climate Change Adaptation Strategies Among Farmers in Sokoto State, Nigeria

**[1]Ikpe Elisha and [2]Kim Idoma**

[1]Department of Geography, Federal College of Education, Odugbo, Benue State, Nigeria
[2]Department of Geography, Gombe State University, Gombe State, Nigeria

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**ABSTRACT:** *This study examined the determinants for adopting climate change adaptation strategies among farmers in Sokoto State, Nigeria. The aim of the study was to find out what determines the choice and use of adaptation strategies in the study area. A systematic multi-stage sampling technique was used to select 6 Local Government Areas in Sokoto State. Seven hundred and eighty-three (783) farmers were purposively selected. Structured questionnaire and Focussed Group Discussion were used to obtain the required information from the selected farmers. Frequency, percentages, Relative Importance Index Technique and ordered logistic regression were used for data analysis and presentation. The results showed that 97% stated that it is possible to adapt to climate change. Multiple cropping, use of early maturing crop varieties and the use of organic manure are the most effective adaptation strategies in the study area among others. The logistic regression model analysis showed that age, gender, marital status, household size, educational level and years of climate change awareness of the farmers have no significant relationship with the choice of adaptation strategies in the study area. Based on the findings of the study, major recommendations made include: continuous raising of awareness on climate change to the farmers by extension agents, Non-Governmental Organisations and farmers' cooperatives; farmers should be encouraged to participate in agricultural extension services which will educate them on the effects of climate change and viable adaptation strategies and adequate provision of weather forecast records and climate related data for the farmers.*

**KEY WORDS:** Adaptation Strategies; Agriculture; Climate Change; Farmers and Multiple Cropping

## INTRODUCTION

Climate change is among the most pressing global challenges of our time. Climate change is real. It respects no political boundary and the risks it poses to nation's socio-economic development are enormous. The Intergovernmental Panel on Climate Change (IPCC) [1] found that human-induced global warming has already caused an unprecedented challenge to our lives and societies here and now. The impact of climate change is already being experienced across the globe and affects all of us living now. The reports of the IPCC affirm the seriousness of this challenge already today and the risks ahead if we do not enhance action on mitigation and climate change adaptation [2]. Agricultural production and food security are likely to be severely compromised by climate change thereby putting some regions of marginal agriculture out of production [1]. Climate change is an urgent global crisis affecting ecosystems, economies, and human health worldwide. One of the most significant contributors to this phenomenon is the increasing emission of greenhouse gases from various sources, such as transportation and industrial activities [3].

Increasing weather and climate extreme events have already exposed millions of people to acute food insecurity and reduced water security, with the largest impacts observed in many locations and/or communities in Africa, Asia, Central and South America, Small Islands and the Arctic (high confidence). Climate change will thus increasingly add pressure on food production systems, undermining food security [4]. Africa is one of the continents that is most vulnerable to the effect of climate change and climate variability. Agriculture will be affected by an increase in temperature, a longer growing season, increased but more unevenly distributed precipitation and more extreme weather events. Harvests may be negatively impacted because of either increased or decreased precipitation. There will be increased risks of drought and flooding, reduced water accessibility, an increased spread of disease and invasive species, changes in species distribution and increased heat stress. Climate change may also lead to more disruptions to relevant trade and infrastructure in the event of extreme weather situations. Increased domestic production of food can reduce the vulnerability to global disruptions to food production, trade, and infrastructure [2]. In the short and medium term, Nigerian agriculture may benefit from larger harvests of certain crops and the cultivation of new crops. However, a changing climate represents greater risks. To reach a sustainable production of food, agriculture needs to adapt to meet the conditions of a changing climate.

Adaptation is defined, in human systems, as the process of adjustment to actual or expected climate and its effects in order to moderate harm or take advantage of beneficial opportunities. Adaptation is the process of adjustment to actual climate and its effects; human intervention may facilitate this. It plays a key role in reducing exposure and vulnerability to climate change in natural systems. Adaptation in ecological systems includes autonomous adjustments through ecological and evolutionary processes, bouncing back and returning to a previous state after a disturbance. In human systems, adaptation can be anticipatory or reactive, as well as incremental and / or transformational. Adaptation Strategies refers to the practice of identifying options or methods to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency and feasibility [4].

To deal with the negative effects of climate change, there are several adaptation strategies that can be adopted in different situations. In general, the more adaptation there is, the less will be the impacts to which we will have to adjust, and the less the risk for which we will have to try and prepare.

Adaptation has three possible objectives: to reduce exposure to the risk of damage; to develop the capacity to cope with unavoidable damages; and to take advantage of new opportunities [5]. Conversely, the greater the degree of preparatory adaptation, the less may be the impacts associated with any given degree of climate change. Adaptation strategies present a complementary approach to mitigation. One important issue in agricultural adaptation to climate change is the way farmers update their expectations of the climate in response to unusual weather patterns. Our reactions to the effect of climate change are measured in terms of adaptation strategies [6].

[7] suggested relevant adaptation strategies that can be adopted in addressing crop failures in the semi-arid region of Nigeria as follows: provision of accurate and timely weather forecasting; enhancing agricultural extension services; adoption of drought-tolerant and early maturing varieties of crops; diversifying livelihoods to improve income; increasing and upgrading crop storage facilities; expanding and optimizing existing irrigation infrastructures; helping farmers to secure agricultural insurance and access to loan; multiple cropping system; planting of trees (afforestation) and agroforestry; control of pests - insects and birds; growing more cover crops like potatoes and melon to protect soils from erosion; stabilizing gullies and erosion sites. According to [8] farmers in Sokoto uses various adaptation strategies such as adaptation strategies in crop production.

Sokoto State is in the semi-arid region, where desertification is intensifying, and rainfall is unreliable for crop production [9]. [10] reported that rainfall in Sokoto State as in other parts of the Sudan-Sahelian savannah ecological belt is very erratic and characterized by late onset and early cessation which could have adverse effect on effective crop cultivation if no viable adaptation strategies are put in place. Therefore, adaptation strategies are very important in crop production in Sokoto State. Thus, what informed the choice of adaptation strategies in Sokoto is the focus of this research.

## METHODOLOGY AND STUDY AREA

### Study Area

Sokoto State is in the North-West Sudano-Sahelian Savannah ecological belt of Nigeria between Latitudes 11° 03' and 13° 50' N of the Equator and Longitudes 4° 14' and 6° 40' E of the Greenwich Meridian [11]. Its headquarters is at Sokoto. It has an area of 25,973 $Km^2$. It is bounded by Niger Republic to the north, Zamfara State to the east and south and Kebbi State to the west. Presently, the State has twenty-three (23) Local Government Areas (LGAs) (see Figure i).


**Figure: i. Sokoto State (Study Area)**
**Source**: Administrative Map of Sokoto State (2022).

The climate of Sokoto is tropical continental and is dominated by two opposing air masses: tropical maritime and tropical continental. The tropical maritime is moist and blows from the Atlantic, while the tropical continental air mass, is dry and blows from the Sahara Desert. The rainy seasons are usually short, which is often within the ranges of four to five months (May/June to September/October). Owing to seasonal fluctuations, it could even drop to less than four months. Hence, evapotranspiration is usually high most especially in the dry season [12]. The annual rainfall is between 500mm in the north and 800mm to the south. The showers rarely last long and are far from the regular torrential rain known in wet tropical regions. According to [13], this short growing season affect crop yield and makes it difficult to cultivate crops that require longer growing season and high amount of rainfall; but favours grains like millet, sorghum and maize which have short growing season and require low amount of rainfall. Overall, Sokoto is in the semi–arid zone of Nigeria.

The average temperature during the dry season is about 40.6ºC. However, maximum daytime temperatures are for most of the year generally under 40°C. The hottest months are February to April when daytime temperatures can exceed 45°C. [14] reported that high temperature affects C4 plants such as maize through its effects on the availability of water which is very important in the process of photosynthesis. From late October to February, during the dry season, the climate is dominated by the Harmattan wind blowing Sahara dust over the land. The dust dims the sunlight thereby lowering temperatures significantly and leading to the inconvenience of dust everywhere in houses [11].

According to the 2006 census, Sokoto State has a population of 3,702,676 [15]. It has a population density of 169.1 $Km^2$. Sokoto is mainly populated by Hausa, Fulani and the Zabarmawa people. A greater proportion of the inhabitants are rural dwellers (80 per cent) with only 20 per cent dwelling in the urban settlements [11]. The people are mainly farmers and traders. Some inhabitants of the area also engage in artisanal fishing along rivers Sokoto and Rima as well as along some seasonal streams and ponds. In the more recent time, declining agricultural productivities and dwindling income from both agriculture, animal husbandry and fishing has compelled many people in the state to pursue some off-farm activities as a means of income diversification both during the wet and dry seasons [16].

## METHODOLOGY

A multi-stage sampling technique was used for the study. Six LGAs (Gwadabawa, Rabah, Kware, Tangaza, Kebbe and Tureta) were selected. Purposive sampling technique was used to select the respondents from 19 sampled settlements. Farmers above thirty (30) years of age and who must have lived in the study area for at least twenty (20) years were identified through the “Sarkin Noma” (Head of the Farmers) and the village Heads. The reason for this decision was that those within the age bracket had the information needed about climate change in the area. Questionnaire was administered proportionately among the selected settlements.

Sample size was based on [17] sample size determination. It stated that where a population range is between 500,000 and 10,000,000 the sample size is 783 at 95% confidence level and 3.5% margin of error. 3.5% margin of error was chosen in order to minimise the margin of error as smaller sample sizes will yield larger margins of error. Seven hundred and sixty-two (762) questionnaires were successfully returned. The farmers’ responses to questions on adaptation strategies in form of Likert scale (3 = Always, 2= Rarely and 1= Not at all) were analysed using Relative Importance Index Technique (RII).

Ordered logistic regression model was used to analyse the determinants of climate change adaptation strategies among the farmers in the study area. Age, gender, marital status, household size, education and years of residency of the farmers were used to show whether there is a significant relationship with the choice of adaptation strategies used in the study area. Relative Importance Index Technique (RII) was used to determine the extent of adoption of the various adaptation strategies by farmers. The various strategies used by the farmers were examined and ranked in terms of their frequency using the Relative Importance Index (RII) [18] and [19].

RII is denoted by $\Sigma W / (A*N)$ ----------------------- (1)
Where;
W = Weight given to each factor by the respondents,
A = Highest weight (i.e., 3 in this case),

N = the total number of respondents. The three-point scale ranged from 1 (Not at all) to 3 (Always). The higher the value of RII, the more the rate of adoption of adaptation strategies in the study area.

## RESULTS AND DISCUSSION

### Demographic characteristics of the farmers

The demographic characteristics of the farmers in the selected LGAs were identified, analyzed and presented in Table 1 and 2

**Table 1: Demographic characteristics of the farmers**

| **Distribution of Farmers by Sex** | | |
|---|---|---|
| **Variable** | **Respondents** | **Percentage** |
| Male | 724 | 95 |
| Female | 38 | 5 |
| **Total** | **762** | **100** |
| | | |
| **Distribution of the Farmers by Age** | | |
| **Age** | **Respondents** | **Percentage** |
| 30 – 39 | 200 | 26 |
| 40 – 49 | 215 | 28 |
| 50 – 59 | 206 | 27 |
| 60 – 69 | 137 | 18 |
| 70 & above | 4 | 1 |
| **Total** | **762** | **100** |
| | | |
| **Religious Belief of the Framers** | | |
| **Religion** | **Respondents** | **Percentage** |
| Islam | 737 | 97 |
| Christianity | 25 | 3 |
| **Total** | **762** | **100** |
| | | |
| **Marital Status of the Farmers** | | |
| **Marital Status** | **Respondents** | **Percentage** |
| Married | 685 | 90 |
| Divorced | 15 | 2 |
| Single | 42 | 5.5 |
| Widowed | 20 | 2.5 |
| **Total** | **762** | **100** |

A majority (95 per cent) of the sampled farmers were male, while 5 per cent were female. That majority of the farmers were male might be because, male have a dominant role to play in the family as household heads in providing the households basic needs such as food. It has been generally observed that in some parts of Africa, including Nigeria, womenfolk are often deprived of property rights owing to social barriers. As a result, they tend to have lesser capabilities and resources than men [20]. This result agrees with the findings of [21] which reported that males dominate the agricultural workforce in Sokoto State with 99.1 per cent. The high proportion of males to females in Sokoto State may be because religion and custom play crucial roles in the livelihoods of the people of the state.

The age distribution of the farmers as presented in Table 1, shows that 26 per cent fell within 30 – 39 years; 28 per cent fell within 41 – 49 years; 27 per cent fell within 51 - 59 years; 18 per cent fell within 61 – 69 years and 1 per cent fell within 70 years and above. Majority (74 per cent) of the farmers fell within the age of 41 and above. The average age of the farmers was 49 years.

Table 1 further indicates that 97 per cent of the farmers are Muslims, while 3 per cent are Christians. The religious belief/faith of the respondents plays a major role on their perception of climate change and adaptation measures, especially on what causes climate change. According to [22], the influence of religion, especially the Christian principles was evident in her study area (Jamaica) in the assertion that climate change is an act of God, a punishment for man's disobedience and a sign to end of the world.

The result shows that 90 per cent of the sampled farmers were married, about 2 per cent were divorced, while 5.5 per cent were single and 2.5 per cent were widowed. These indicate that majority of the farming household members were married. This suggests that married household members have many mouths to feed, therefore, engage more in farming activities in order to provide food and income for the family than singled and divorced household members.

**Table 2: Demographic characteristics of the farmers**

| **Distribution of Farmers by Level of Education** | | |
|---|---|---|
| **Level of Education** | **Respondents** | **Percentage** |
| Primary | 122 | 16 |
| Secondary | 175 | 23 |
| Tertiary | 153 | 20 |
| No Formal Education at all | 312 | 41 |
| **Total** | **762** | **100** |
| | | |
| **Household Size of the Farmers** | | |
| **Household Size** | **Respondents** | **Percentage** |
| 1 – 5 | 54 | 7 |
| 6 – 10 | 245 | 32 |
| 11 – 15 | 174 | 23 |
| 16 – 20 | 144 | 19 |
| 21 – 25 | 103 | 13.5 |
| 26 & above | 42 | 5.5 |

| | | |
|---|---|---|
| **Total** | **762** | **100** |

**Farmers' Years of Residency**

| Years of Residency | Respondents | Percentage |
|---|---|---|
| 20 – 30 | 295 | 39 |
| 31 – 40 | 248 | 32 |
| 41 & above | 219 | 29 |
| **Total** | **762** | **100** |

**Source:** Field work, 2022

Table 2 presented that 16 per cent of the farmers attended primary school; 23 per cent attended secondary school; 20 per cent attended higher institution at various levels; 41 per cent had no formal education at all. The results further indicate that most of the respondents received various forms of education in the study area. This might have probably helped them in their farming activities. According to [23], education has a positive and highly significant relationship between the farmers' level of education with the level of investment in indigenous and emerging climate change adaptation practices. This is to be expected as educated farmers may better understand and process information provided by different sources regarding new farm technologies, thereby increasing their allocation and technical efficiency.

Family labour is recognized as a major source of labour supply in smallholder grain crop production in most parts of Africa, including Nigeria. This comprises the labour of all males, females including children in a household, who contribute their mental and physical efforts to the household holdings. More so, Table 2 shows the family size distribution of respondents. The result show that majority (32 per cent) of the farmers are within the household size of 6 - 10, followed by 23 per cent which fell within the household size of 11 to 15; 19 per cent are within the range of 16 to 20 household size; 13.5 per cent fell within the range of 21 to 25 household size, while 7 per cent fell within the household size of 1 to 5 and 5.6 per cent fell within the household size of 26 household members and above.

### 3.2 Adapting to Climate Change

The results of the possibility of farmers' adapting to climate change are presented in Fig. 2.

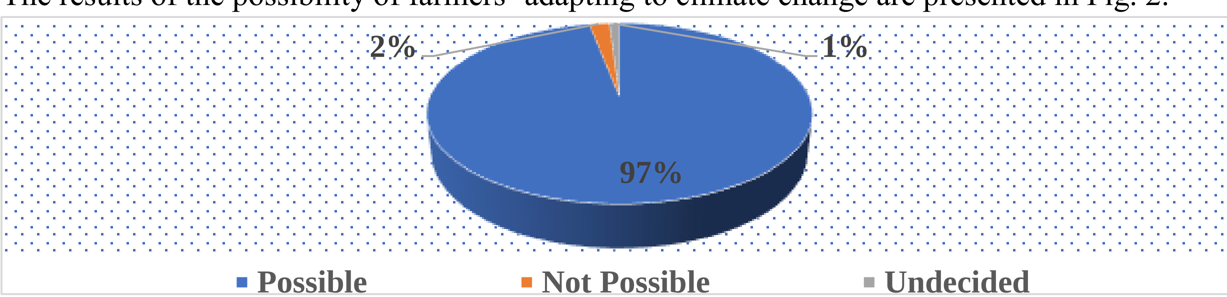


**Figure ii: Possibility of Adapting to Climate Change**

Figure ii shows that 97 per cent of the farmers stated that it is possible to adapt to climate change, 2 per cent stated that it is not possible to adapt to climate change in the study area, while 1 per cent were undecided. This result corroborated the findings of [7] which stated that through adaptation strategies it is possible for farmers to adapt to the effect of climate change in the semi-arid regions of Nigeria. [6] further stated that through viable adaptation strategies, farmers have been able to effectively cultivate grains in Goronyo, Sokoto State. The results also agree with the findings of [24] which reported that farmers in Kano State are coping with the effects of climate change through various adaptation strategies.

Table 3 shows twenty-five indigenous and emerging strategies for climate change adaptation used by farmers in the study area. The farmers' responses to questions on adaptation strategies in form of Likert scale (3 = Always, 2= Rarely and 1= Not at all) were analysed using Relative Importance Index Technique (RII). The contribution of each of the adaptation strategies used by the farmers was examined; and the ranking of the attributes in terms of their effectiveness as perceived by the respondents was done using Relative Importance Index (RII) [18], [19]. The higher the value of RII, the more important or effective was the adaptation strategy to climate change in the study area.

**Table 3 Adaptation Strategies used by Farmers in the Study Area (n=762)**

| S/N | Adaptation Strategies | Always | Rarely | Not at all | RII | Rank |
|---|---|---|---|---|---|---|
| **1** | Early and late planting | 615 | 125 | 22 | 0.9 | 2 |
| **2** | Soil conservation and water | 114 | 322 | 326 | 0.6 | 16 |
| **3** | Use of organic manure | 644 | 78 | 40 | 0.9 | 2 |
| **4** | Use of inorganic fertilizer | 547 | 145 | 70 | 0.9 | 2 |
| **5** | Planting pest and disease resistant crop | 535 | 172 | 55 | 0.9 | 2 |
| **6** | Crop varieties that are well acclimatized | 612 | 136 | 14 | 0.9 | 2 |
| **7** | Draining of wetland for crop cultivation | 43 | 45 | 674 | 0.4 | 23 |
| **8** | Contour ploughing around farmland | 133 | 102 | 527 | 0.5 | 18 |
| **9** | Planting of cover crops | 565 | 156 | 41 | 0.9 | 2 |
| **10** | Use of irrigation system/water storage | 125 | 174 | 463 | 0.5 | 18 |
| **11** | Reforestation/Afforestation | 18 | 70 | 674 | 0.4 | 23 |
| **12** | Use of herbicide, insecticide etc. | 590 | 98 | 74 | 0.9 | 2 |
| **13** | Increase in number of weeding | 344 | 262 | 156 | 0.7 | 12 |
| **14** | Use of early maturing crop varieties | 678 | 80 | 4 | 0.9 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **15** | Preservation of seedlings for planting | 600 | 123 | 39 | 0.9 | 2 |
| **16** | Use of weather-resistant variety | 590 | 156 | 16 | 0.9 | 2 |
| **17** | Reducing access to erosion prone area | 72 | 180 | 510 | 0.5 | 18 |
| **18** | Mixed farming practices | 281 | 289 | 192 | 0.7 | 12 |
| **19** | Use of recommended planting distance | 165 | 97 | 500 | 0.5 | 18 |
| **20** | Changing the timing of land preparation | 266 | 289 | 207 | 0.7 | 12 |
| **21** | Changing harvesting dates | 223 | 252 | 287 | 0.6 | 16 |
| **22** | Out migration from climate risk areas | 53 | 121 | 588 | 0.4 | 23 |
| **23** | Use of windbreaks/shelter belts | 39 | 211 | 512 | 0.5 | 18 |
| **24** | Loans, grants and subsidies | 246 | 307 | 209 | 0.7 | 12 |
| **25** | Mixed cropping | 744 | 16 | 2 | 1.0 | 1 |

**Source:** Field work, 2022

The result revealed that out of the 25 adaptive strategies, 11 were "highly adopted" by the farmers as reflected in their RII scores of 0.9 and 1.0. These strategies for climate change adaptation included early and late planting, use of organic manure, use of chemical fertilizer, planting of pest and disease resistant crop that are well acclimatized, planting of cover crops, use of early maturing seeds, preservation of seeds; use of weather resistant varieties and mixed cropping systems (Table 3). Soil conservation and water, contour ploughing around farmland, use of irrigation system, use of chemicals like herbicide, increase in number of weeding, use of recommended planting distance, changing harvest dates, and access to loans, grants and subsidies were "rarely adopted". The RII ranked adaptation strategies shows that mixed cropping was ranked first among the 25 adaptation strategies in the study area. According to [25], multiple cropping is the dominant cropping system used by small-holder farmers in the drought prone, semi-arid tropics of West Africa. The system is commonly practiced in northern Nigeria where cereals (maize, millet, and sorghum), legumes (beans) and nuts (groundnuts) are grown together. The advantages of mixing crops with varying attributes are in terms of maturity periods (e.g. maize and beans), drought tolerance (maize, millet and sorghum), input requirements (cereals and legumes) and the end users of the product (e.g. maize as food and sunflower for cash).

**Table 4: Multiple Cropping Adaptation and Socio-economic Activities of the Farmers**

| Multiple Cropping | | B | Std. Error | Wald | Df | Sig. |
|---|---|---|---|---|---|---|
| **Socio-economic characteristics** | Intercept | -49.978 | 4695.370 | .000 | 1 | .992 |
| | 30 – 40 years | 15.862 | 1374.952 | .000 | 1 | .991 |
| | 41 – 50 years | 15.829 | 1374.952 | .000 | 1 | .991 |
| **Age of the Farmers** | 51 – 60 years | 15.822 | 1374.952 | .000 | 1 | .991 |
| | 61 – 70 years | 15.623 | 1374.950 | .000 | 1 | .991 |
| **Gender** | Male | 16.355 | .000 | . | 1 | .991 |
| **Marital Status** | Married | 15.782 | 4489.544 | .000 | 1 | .997 |
| | Divorced | 17.461 | 4489.544 | .000 | 1 | .997 |
| | Single | 17.077 | 4489.544 | .000 | 1 | .997 |
| **Size of Household** | 1 – 5 | .318 | 1.489 | .046 | 1 | .831 |
| | 6 – 10 | .452 | 1.149 | .155 | 1 | .694 |
| | 11 – 15 | -1.534 | 1.453 | 1.115 | 1 | .291 |
| | 16 – 20 | -.934 | 1.268 | .543 | 1 | .461 |
| | 21 – 25 | -.416 | 1.202 | .120 | 1 | .730 |
| **Educational Qualification** | Primary | -16.306 | 1706.885 | .000 | 1 | .992 |
| | Secondary | -.487 | 1.234 | .156 | 1 | .693 |
| | Tertiary | -16.783 | 1908.564 | .000 | 1 | .993 |
| | Koranic | -.061 | 1.162 | .003 | 1 | .958 |
| **Years of Residency** | 20 – 30 years | .076 | 1.236 | .004 | 1 | .951 |
| | 31 – 40 years | -.608 | 1.254 | .235 | 1 | .628 |

**Source:** Field work, 2022

**Table 5: Use of Early Maturing Varieties and Socio-economic Activities of the Farmers**

| Early Maturing Crop Varieties | | B | Std. Error | Wald | df | Sig. |
|---|---|---|---|---|---|---|
| **Socio-economic characteristics** | **Intercept** | -48.332 | 5379.932 | .000 | 1 | .993 |
| | 31 – 40 years | 16.034 | 1332.336 | .000 | 1 | .990 |
| | 41 – 50 years | 15.911 | 1332.336 | .000 | 1 | .990 |
| **Age** | 51 – 60 years | 15.712 | 1332.338 | .000 | 1 | .990 |
| | 61 – 70 years | 14.912 | 1332.336 | .000 | 1 | .990 |
| **Gender** | Male | 15.672 | .000 | . | 1 | 990 |
| | Female | $0^c$ | . | . | 0 | . |
| **Marital Status** | Married | 15.526 | 5212.346 | .000 | 1 | .998 |
| | Divorced | 17.015 | 5212.346 | .000 | 1 | .997 |
| | Single | 16.538 | 5212.346 | .000 | 1 | .997 |
| **Household Size** | 1 – 5 | .154 | 1.520 | .010 | 1 | .919 |
| | 6 – 10 | .297 | 1.175 | .064 | 1 | .800 |
| | 11 – 15 | -2.043 | 1.470 | 1.931 | 1 | .165 |
| | 16 – 20 | -1.122 | 1.291 | .756 | 1 | .385 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 20 – 25 | -.847 | 1.223 | .480 | 1 | .489 |
| **Educational Qualification** | Primary | -16.706 | 1643.535 | .000 | 1 | .992 |
| | Secondary | -.789 | 1.261 | .392 | 1 | .531 |
| | Tertiary | -17.464 | 1479.028 | .000 | 1 | .991 |
| | Koranic | -.474 | 1.192 | .158 | 1 | .691 |
| **Years of Residency** | 20 – 30 years | -.244 | 1.241 | .039 | 1 | .844 |
| | 31 – 40 years | -.821 | 1.260 | .424 | 1 | .515 |

**Source:** Field work, 2022

**Table 6: Use of Organic Manure and Socio-economic Activities of the Farmers**

| Use of Organic Manure | | B | Std. Error | Wald | Df | Sig. |
|---|---|---|---|---|---|---|
| **Socio-economic characteristics** | Intercept | -49.223 | 5069.039 | .000 | 1 | .992 |
| | 31 – 40 years | 15.781 | 1391.580 | .000 | 1 | .991 |
| | 41 – 50 years | 15.589 | 1391.580 | .000 | 1 | .991 |
| **Age:** | 51 – 60 years | 15.673 | 1391.580 | .000 | 1 | .991 |
| | 61 – 70 years | 15.588 | 1391.578 | .000 | 1 | .991 |
| **Gender** | Male | 15.909 | .000 | . | 1 | . |
| | Female | $0^c$ | . | . | 0 | . |
| **Marital Status** | Married | 15.705 | 4874.285 | .000 | 1 | .997 |
| | Divorced | 17.443 | 4874.285 | .000 | 1 | .997 |
| | Single | 16.685 | 4874.285 | .000 | 1 | .997 |
| **Size of Household** | 1 – 5 | -.201 | 1.484 | .018 | 1 | .892 |
| | 6 – 10 | .310 | 1.158 | .072 | 1 | .789 |
| | 11 – 15 | -1.930 | 1.459 | 1.751 | 1 | .186 |
| | 16 – 20 | -1.022 | 1.277 | .640 | 1 | .424 |
| | 21 – 25 | -.465 | 1.211 | .148 | 1 | .701 |
| **Educational Qualifications** | Primary education | -15.947 | 1634.236 | .000 | 1 | .992 |
| | Secondary education | -.256 | 1.227 | .044 | 1 | .835 |
| | Tertiary education | -16.971 | 1492.662 | .000 | 1 | .991 |
| | Koranic education | .042 | 1.156 | .001 | 1 | .971 |
| **Years of Residency** | 20 – 30 years | -.192 | 1.233 | .024 | 1 | .876 |
| | 31 – 40 years | -.864 | 1.254 | .475 | 1 | .491 |

**Source:** Field work, 2022

**Age of the Farmers and Adaptation Strategies**

As to whether age was a factor that determined the choice of multiple cropping, use of early maturing crop varieties and the use of organic manure as adaptation strategies in the study area, the result revealed that age did not play a significant role in the choice of adaptation strategies. Findings from Tables 4, 5 and 6 revealed that a farmer who was between 30 to 40 years were 15.862 times more likely to adopt multiple cropping system, 16.034 times more likely to adopt the use of early maturing crop varieties and 15.781 times more likely to adopt the use of organic manure than a farmer who was over 60 years; and farmers who were 41 – 50 years were 15.829, 15.911 and 15.589 times as likely to adopt multiple cropping, use of early maturing crop varieties and the use of organic manure respectively as adaptation strategies than farmers who were over 61 years of age (Tables 4, 5 and 6).

That age is negatively correlated to the probability of choosing and using multiple cropping, use of early maturing crop varieties and the use of organic manure as adaptation strategies to climate change in Sokoto State shows that young farmers have a longer planning horizon and have ability to cope with climate change and climate variability risks in grain crop production than the older counterparts. This result agrees with the findings of [26] which found that GM corn adoption increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement. Also, the work of [27] found that age is inversely related to the probability of choosing and using mono crop-livestock under irrigation in Southern Africa. According to [23], older farmers are more likely to be risk averse, especially regarding climate change matters, than younger ones as age may likely endow the farmers with the requisite experience that will enable them make better assessment of the risks involved in climate change adaptation investment decisions. They further noted that older farmers have more experience and can take healthier production decisions than younger ones. Older farmers may have a shorter time horizon and be less likely to invest in novel technologies.

**Gender of the Farmers and Adaptation Strategies**

Result on gender revealed that though insignificant (0.991, 0.990 and 0.991 for multiple cropping, use of early maturing crop varieties and the use of organic manure respectively) as presented in Tables 4,5 and 6 in influencing adoption of climate change adaptation in Sokoto State, the male farmers were 16.355, 15.672 and 15.909 times as likely to adopt multiple cropping, use of early maturing crop varieties and the use of organic manure adaptation strategies respectively as their female counterparts. This indicated that male farmers in the study area were more likely to adopt climate change adaptation.

The result agrees with [28] which reported that male farmers have a higher probability of choosing, using and intensifying multiple cropping, use of early maturing crop varieties and the use of organic manure, than their female counterparts among the whole sampled farmers in the study area. The result further disagreed with the study of [29] which reported that female farmers in South Africa are more likely to take up climate adaptation measures than their male counterpart.

**Marital Status of the Farmers and Adaptation Strategies**

On marital status of the farmers, findings revealed that marital status did not play a significant role in adopting multiple cropping, use of early maturing crop varieties and the use of organic manure as adaptation strategies (0.997, 0.998 and 0.997 respectively). The result as presented in Table 4 means that a farmer who was single increases his/her likelihood of adopting either multiple cropping, use of early maturing crop varieties and the use of organic manure 15.782, 15.526 and 15.705 times respectively than a married farmer. This indicates that a single farmer was more likely to adopt multiple cropping, uses of early maturing crop varieties and the use of organic manure as adaptation strategies than a farmer who had divorced. More so, a farmer who was single was more likely to adopt multiple cropping, use of early maturing crop varieties and the use of organic manure 17.077, 16.538 and 16.685 times respectively than a farmer that was widowed.

**Household Size of the Farmers and Adaptation Strategies**

The result shows that there was a negative relationship between household size and the probability of choosing multiple cropping, uses of early maturing crop varieties and the use of organic manure as adaptation strategies among farmers in Sokoto State (Tables 4,5 and 6). That there is a negative relationship between household size and the probability of choosing multiple cropping, uses of early maturing crop varieties and the use of organic manure as adaptation strategies as adaptation strategies among farmers in Sokoto State implies that the larger farmers' families are able to choose these main climate change adaptation strategies than the smaller families. This result agrees with the finding of [31] which found out that household size is negatively related to adoption of fallow as land management technology in Uganda. The result disagrees with the findings of [30] which reported a significant relationship between the household size of the farmers and their adoption of adaptation strategies. They reiterated that farmers with large household sizes have enough family labour to complete planting of crops within a very short period to prevent the possibility of planting late which might be affected by the changing climatic condition.

**Education Level of the Farmers and Adaptation Strategies**

Education of the farmers has an inverse relationship with the probability of a farmer choosing and using multiple cropping, use of early maturing crop varieties and the use of organic manure as adaptation strategies in the study area (Table 4.)

The inverse relationship between education and these adaptation strategies is contrary to expectations that better educated farmers are more likely to choose and use climate change adaptation strategies in the study area. It could be probably deduced that the education acquired by these farmers is not formal agricultural education; it is assumed that a farmer with formal agricultural education will be more likely to innovate due to the higher associated skill level. This result agrees with the finding of [30] that found out that education was negatively related to adoption of terracing and inorganic fertilizer as land management practices in Uganda.

That there is no significant relationship between education and adaptation strategies disagrees with the findings of [23] which reported a positive and highly significant relationship between the farmers' level of education with the level of investment in indigenous climate change adaptation practices. This is to be expected as educated farmers may better understand and process information provided by different sources regarding new farm technologies, thereby increasing their allocation and technical efficiency.

**Level of Climate Change Awareness and Adaptation Strategies**

Level of climate change awareness has a negative relationship with the probability of choosing and using multiple crop varieties, use of early maturing crop varieties and the use of organic manure among the farmers in the study area (Tables 4,5 and 6). This result is contrary to the findings of [23] which reported that there is a positive and significant relationship between the farmers' level of awareness of climate change effects with the adoption and investment in indigenous climate change adaptation practices. This underscores the importance of awareness in adaptation measures. The awareness of climate problems and the potential benefits of acting is an important determinant of adoption of agricultural technologies [27]. [32] argued that farmer's awareness of change in climate attributes (temperature and precipitation) is important to adaptation decision making. For example, [33] reported that farmers awareness and perceptions of soil erosion problem as a result of changes in climate, positively and significantly affect their decisions to adopt soil conservation measures.

## CONCLUSION

This study has examined the determinants for the adoption of climate change adaptation strategies among farmers in Sokoto State, Nigeria. The research established that mixed cropping, use of improved seed varieties and use of organic manure are perceived to be the most effective adaptation strategies in the study area. Results showed that farmers in the study area are aware of climate change. The study also revealed that age, gender, marital status, household size and the educational level of the farmers do not influence the choice of adaptation strategies in the study area.

**Recommendation**

In view of the above there is the need for the government and NGOs to continue supporting the farmers to increase their adaptation capacities by continuous enlightenment on climate change issues and viable adaptation strategies, use of farm extension workers for agricultural education and updates; introduction of other emerging strategies; provision of improved seed varieties and the development of sustainable irrigation project to complement rainfall and for dry season farming in the study area.

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