SSRG International Journal of Agriculture and Environmental Science
ISSN: 2394 – 2568 /doi:10.14445/23942568/IJAES-V8I2P107
Volume 8 Issue 2, 40-47, Mar-April 2021

Constraints to Adoption of Climate Change Adaptation Strategies among Cassava Farming Households in Southwest Nigeria

[1]ATURAMU Oluyede Adeleke, [2]Owoeye Rufus Sunday and [3]Ijigbade Justin Orimisan

[1]Department of Agricultural Science and Technology, Bamidele Olumilua University of Education, Science and Technology, Ikere Ekiti, Nigeria
[2]Department of Agricultural Economics and Extension Services, Ekiti State University, Ado-Ekiti, Nigeria
[3]Department of Agricultural Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Received Date: 29 March 2021
Revised Date: 04 May 2021
Accepted Date: 08 May 2021

Abstract
The study was examined the effect of climate change adaptation strategies on cassava production in Southwest Nigeria, where two different agro-ecological zones (AEZ) (rain forest and savannah) were chosen for the study. The study selected 300 cassava producers from the two AEZs, i.e., 150 respondents from each zone for the study. Data analysis was carried out using descriptive statistics. The result showed that cassava farmers interviewed in the study area were still in their active age, fairly educated, virtually married, having long years of farming experience, well-informed, and aware of climate change, but failed to scale up their farming operations. The most commonly practiced climate adaptation strategies were; the use of improved varieties, multiple planting dates, increasing farm size, mulching, farm plot fragmentation, and crop diversification, while the mostly reported challenges to climate change adaptation strategies were; insufficient access and awareness about the program on climate change adaptation, inadequate access to weather and climate forecast information, cost of labor and high cost of improved crop varieties. The study recommended that farmers, via extension agents, should be encouraged to practice multiple adaptation strategies.

Keywords: *Constraints, climate change, adaptation strategies, cassava farmers*

I. INTRODUCTION

Climate change which manifests itself as a change in rainfall patterns and temperature adversely impacts the economic and social survival of the majority of the population in Africa and particularly in sub-Saharan Africa. The major sources of livelihood for rural poor in Africa such as water resources, agriculture (crop production and animal husbandry), health, ecosystems and biodiversity, forestry, and coastal zones are the most vulnerable areas or sectors To climate change. Climate change remains a major threat to food security and sustainable management of natural resources. Studies indicated that if adequate measures are not taken to cop up the impacts of climate change in sub-Sahara Africa, there will be a predicted loss of 2-7% of GDP by 2100 in parts of sub-Sahara Africa; 2-4% and 0.4-1.3% in West and Central Africa, and northern and southern Africa respectively [1]

Sub Saharan Africa is among the most vulnerable regions to climate change impacts due to the fact that the majority of the population highly dependent on rain-fed agriculture for their economic activities as well as for sustenance of their livelihood [2]. The poor performance of the agriculture sector and rapid population growth, in combination with the adverse impacts of climate change, causes a large segment of the sub-Sahara African population to live in abject poverty. If the current trend continues to lead to significant long term changes in rainfall patterns and temperature, which affect agriculture, it is highly likely that this situation will lead to a significant reduction in food security, worsening water security, increase in animal and crop pests, and disease infestation, among others [3]

Generally, the farmers have experienced increased pests and crop diseases, increased crop water requirements, leading to crop failures, reduced crop production in countries or regions where arable farming is predominant [4; 5; 6; 7; 8; 9]. Livestock farmers reported that climate change and climate variability have led to decreased livestock weight and an increase in livestock death. These imply loss of farm income and livelihood for the majority of the rural population; hence, a general deterioration in their welfare [10; 11; 12; 13]

Smallholder farmers in Nigeria have vast adaptive capacities to the impact of climate change, consequently influencing the status of food security among farming communities differently. Most regions in Nigeria have been seriously impacted by climate change and climate variability, including the Southwest region, whereby there have been increased frequency of drought and floods, changes in the timing of rainfall, rain comes late than expected, followed by terrible drought and famine [14]. Smallholder farmers in the Southwest region have various adaptive capacities towards the challenges resulting from climate change. Also, they have vast perceptions and capacities on adaptation strategies with various limitations which need to be addressed [15]

A. Study Area

This research work was carried out in Southwest Nigeria. It consists of six States; Ekiti, Ondo, Osun, Oyo, Ogun, and Lagos. The study area lies between longitudes 2^0 3^1 and 6^0 00^1 East of the Greenwich meridian and latitudes 6^0 2^1 and 8^0 37^1 North of the equator with a total land area of 77,818 km^2 and a population of 27,581,992 (NPC, 2006), with 2018 projected population estimate of 39,742,334 based on annual percentage population growth of 2.619% as reported by NPC, 2016.

The study area (Southwest, Nigeria) is bounded in the East by Edo and Delta States, in the North by Kwara and Kogi States, in the West by the Republic of Benin, and in the South by the Gulf of Guinea. The climate of Southwest Nigeria is tropical in nature. The weather condition varies between two distinct seasons in Nigeria; the rainy season (March - October) and the dry season (November - February). The dry season is characterized by the harmattan dust; cold, dry winds from the northern deserts blow into the southern region. The temperature ranges between 21^0C and 34^0C, while the annual rainfall ranges between 1500mm and 3000mm [16]. There is a high temperature during the dry season with heavy rainfall during the rainy season (November to March). The wet season is associated with Southwest monsoon wind from the Atlantic Ocean, while the dry season is associated with the Northeast trade wind from the Sahara desert [17].

The vegetation in Southwest Nigeria is made up of freshwater swamp and mangrove forest, the lowland in the forest stretches inland to Ogun and parts of Ondo State while the secondary forest is towards the Northern boundary where derived and southern savannah exist [18]. There are good soils favorable to agricultural production in the study area. Occupations common among the people of Southwest Nigeria include: farming, hunting, fishing, produce buying, sports, butchering and meat selling, crafts, and trading. Agriculture provides income and employment for about 75% of the populace, and they produce both food and cash crops. The food crops in this area are; rice, yam, cassava, maize, cocoyam, and cowpea, while the cash crops are; cocoa, oil palm, kolanut, plantain, banana, cashew, citrus, and timber [19]

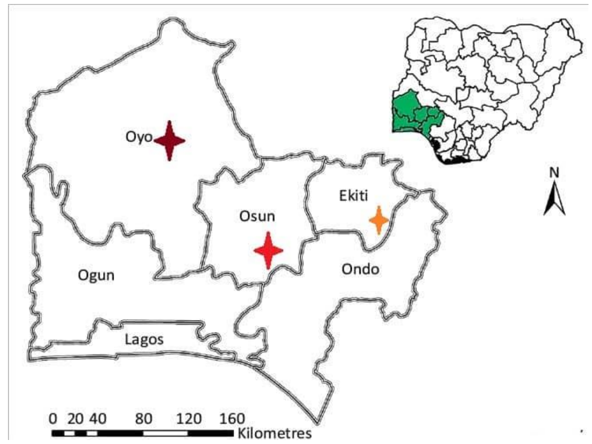

Figure 2: Map of Southwest Nigeria showing the study area
Source: https://t2.gstatic.com/images

B. Sampling Procedure and Sample Size

A multi-stage sampling procedure was used in the selection of location and respondents for the study. At the first stage, three States, Ekiti, Osun, and Oyo, were randomly selected. The second stage involved the purposive selection of two Local Government Areas (LGAs) of different Agricultural Ecological Zones (AEZ), i.e., rain forest and savannah from each State, based on the volume of cassava output. In Ekiti State, Emure and Moba LGAs were selected because they are the highest cassava producing LGAs in the State based on their respective AEZs (Ekiti State Ministry of Agriculture and Rural Development). While Emure LGA belongs to the rain forest zone, Moba falls into the savannah zone. Also, Irepodun and Atakunmosa East LGAs were purposively selected as savannah and rain forest zones in Osun State, respectively based on their level of involvement in cassava production (Osun State Ministry of Agriculture and Food Security), while Olorunsogo and Ibarapa East LGAs were chosen as guinea savannah and rain forest zones in Oyo State based on their output level in cassava production in the State (Oyo State Ministry of Agriculture, Natural Resources and Rural Development). In totality, six (6) LGAs were chosen for the study. The third stage involved the purposive selection of three communities from each LGA chosen based on their level of involvement in cassava production. In all, the study made use of eighteen (18) communities. Based on the population of the communities selected for this study, a simple random sampling procedure was used to select between 15 to 20 respondents per community, indicating that an equal number of respondents were not chosen from each community, but a total of 50 respondents per LGA remained consistent. In all, a total of 300 respondents were interviewed for the study.

C. Data Sources and Collection

Primary data were collected from 300 cassava farmers with the aid of pre-tested, personal interview, and Focus Group Discussion (FGD) sessions. The data comprised of socio-economic characteristics of the cassava farmers such as age, educational level, gender, etc. Others are; various adaptation strategies and constraints to cassava farmers' adaptation strategies.

D. Method of Data Analysis

a) Descriptive statistics

Descriptive statistical analysis, i.e., frequency, percentage, mean, standard deviation, etc. was used to achieve all the stated objectives

II. Results and discussion

A. Socio-economic characteristics of the respondents

Table 1 revealed the distribution of cassava farmers in both AEZs based on their relevant socio-economic characteristics. The result showed that 78.67 and 21.30 percent of the respondents sampled in rain forest AEZ were found to be males and females respectively, 84.67 and 15.33 percent of the respondents from savannah were males and females, respectively. This is in agreement with [17], who noted males are more involved in cassava production in Benue State. The result further reported 54 and 48 years as the mean age of cassava farmers in the rain forest and savannah AEZs, respectively, implying that cassava farmers in the study area were aging. The cassava farmers in the study area were fairly educated, like 41.7, and 26.7 percent of them acquired secondary education; this is expected to help the farmers in resource allocation in order to optimize productivity. The mean farm size cultivated in the entire study area, as revealed by the pooled data, was 1.6 hectares of land. This implies that these cassava farmers were still operating on a small scale, and this will have a tendency to reduce the production of cassava in the study areas. This is in consonance with [20], who noted half of the farmers (50.0%) cultivated between 1-3 hectares of land for cassava production in Ekiti State. The finding revealed that the farmers had started farming when they were young. The mean years of farming experience were 10.6 years, which showed that the cassava farmers are experienced. This is expected to boost their production as they are familiar with the practices involved in cassava production, and they would be able to mitigate against the loss or challenges they face as a result of climate change in the course of production, as it is often said 'experience is the best teacher. From the result, it was clearly reported that the majority (72%) of the rainforest cassava farmers indicated that they were aware of climate change, while the remaining 28% said they were not. Likewise, the majority (96.7%) of the savannah cassava farmers indicated that they were aware of climate change, while the remaining 3.3% said they were not. The result further showed the mean value of income generated in the rain forest and savannah AEZs as ₦273,814 and ₦215,650, respectively

Table 1: Distribution of cassava farmers based on relevant socio-economic characteristics

Socio-economic	Rain forest		Savannah	
variables	frequency	percentage	frequency	percentage
Sex				
Female	32	21.30	23	15.33
Male	118	78.67	127	84.67
Age				
≤30	5	3.3	15	10
31-40	22	14.7	20	13.3
41-50	41	27.3	58	38.7
51-60	61	40.7	40	26.7
>60	21	14	17	11.3
Level of education				
No primary education	18	12	40	26.7

Primary education	63	42	72	48
Secondary education	42	28	30	20
Tertiary education	27	18	8	5.3
Farm size				
≤2.0	85	66.7	104	69.3
2.1-5.0	54	36.0	41	27.3
>5.0	11	7.3	5	3.4
Farming experience				
1-5	33	22	27	18
6-10	47	31.3	42	28
11-15	58	38.7	20	13.3
>15	12	8	61	40.7
Awareness of climate change				
Aware	108	72.0	145	96.7
Not aware	42	28.0	5	3.3
Cassava income				
≤100,000	17	11.3	30	20.0
101,000-200,000	29	19.3	38	25.3
201,000-300,000	46	30.7	40	26.7
301,000-400,000	32	21.4	27	18.0
401,000-500,000	17	11.3	11	7.3
>500,000	9	6.0	4	2.7

Source: Computed from field survey data, 2018

B. Adaptation Strategies Practiced by the Respondents

Out of the 300 respondents sampled in both AEZs, 253 of them, representing 84.33%, revealed that they were aware of climate change incidences, i.e., 108 respondents (72%) from rain forest AEZ and 145 respondents (96.67%) from savannah AEZ as shown on Table 2. These were the respondents who indicated the adaptation strategies they used to mitigate adversity of climate change, while the remaining 47 respondents (15.67%) did not indicate any adaptation strategies they used in the study area, and the result was reported in multiple responses.

From the result, it was revealed that 85.19% and 70.34% of the respondents practiced crop diversification as an adaptation strategy to reduce the scourge of climate change in the rain forest and savannah AEZs, respectively. This implies that they are involved in planting multiple crops to mitigate the adversity of climate change adversity. From these two results, it was evident that cassava farmers from the rain forest AEZ practiced crop diversification more than their counterparts in the savannah AEZ because they enjoyed long days of rainfall. This adaptation practice could have been intensified as a result of climate. This is because different crops have different levels of resilience to weather situations; hence planting many crops in the field could ensure that farmers get some output in the face of extreme climate events. This is in line with the findings of [21], who observed that 81.22% of farmers in Adamawa State, Nigeria practiced crop diversification as a means of reducing climate change risk and uncertainty

The result further showed that 76.85% and 88.97% of the respondents in the rain forest and savannah AEZs used improved varieties of cassava as their adaptation measure to rescue themselves from the adversity being posed by climate change, respectively. From the result, it was made clear that cassava farmers in the savannah AEZ made use of pest and disease resistant species of cassava, the early maturing variety that is well adapted more than their counterparts in the rain forest AEZ. This implies that cassava farmers in the savannah AEZ must be smart in their choice of cassava varieties they plant, bearing in mind that they are disadvantaged and susceptible to climate change threats. This report is in line with the research carried out by [22] in Southern Nigeria, who reported that 48.27% of yam and cassava farmers in the study practiced the use of improved varieties as their adaptation strategies to mitigate climate change threats.

From the result, it was further shown that 64.81% and 82.07% of the respondents in the rain forest and savannah AEZs engaged in off-farm activities to cope with the climate change uncertainties. A good number of them indicated various artisanal jobs, civil service, commercial motor and *okada* driving, etc., that they got themselves engaged in, thereby increasing their sources of livelihood and total income. Since the cassava farmers in the savannah AEZ usually experienced an early stoppage of rainfall (between September and October) and longer delay (late March and early April), meaning that they were not active in farming activities in these periods, engaging in other economic activities for their survival became necessary. The result further showed that 67.59% and 23.45% of the cassava farmers in the rain forest and savannah AEZs adopted multiple planting dates as their adaptation measure to mitigate climate change threats. These included both early and late planting systems, all in a bid to be certainly sure the planting system that would bring higher cassava output. The result made it clear that cassava farmers in rain forests engaged in multiple planting dates more than their counterparts in the savannah AEZ due to the longer days of rainfall they enjoyed. Employing early planting as an adaptation strategy is to ensure that the critical growth stage of the cassava crop did not clash with very high harsh conditions in the season.

While 59.26% of the cassava farmers in rain forest AEZ resorted to increasing farm size, 47.59% of the cassava farmers in savannah engaged in the same adaptation practice as a way of reducing climate change risk and uncertainty. The rationale behind this was that expanding the farm size would undoubtedly increase the volume of cassava output and that the increased farm size would compensate for any potential loss. The little disparity (in favor of cassava farmers in rain forest AEZ) as regards the percentage of cassava farmers who increased their farm size was responsible for the fact that the cassava farmers in rain forest AEZ were more favorable to climate change conditions. The result also revealed that only 12.04% of the cassava farmers in rain forest AEZ practiced mulching while 44.83% of them in savannah AEZ indicated they adopted mulching to reduce the harshness of climate change. Since the cassava farmers in savannah AEZ experienced increased temperature, drought, and delayed rainfall, practicing mulching more than their counterparts in rain forest AEZ became necessary. Mulching was used by the respondents as soil conservation measures. This is aimed at preventing excessive moisture loss, increased soil aeration, and enhance soil moisture-holding capacity.

Regarding farm plots fragmentation, 43.52% and 22.07% of the cassava farmers in the study area used this adaptation practice to reduce climate change uncertainties in the rain forest and savannah AEZs, respectively. Land fragmentation is the number of plots or fragments of land the farmer deliberately used in food crop production in the cropping season in order to cope with climate change [17]. Land fragmentation is inherent in African land tenure, which is part and parcel of the African farming systems. It has also for long been the focus of major criticism of the system. Also, from the result, 47.22% and 27.59% of them changed farmland as a way of reducing climate change scourge in the rain forest and savannah AEZs, respectively, while 9.26% and 13.10% of the cassava farmers in the rain forest and savannah AEZs indicated that they owned livestock to guide against any climate change shocks.

Table 2: Distribution of Respondents according to Adaptation Strategies Practiced (n = 253)

	Rain forest (n=108)		**Savannah (n=145)**	
Adaptation Strategies Practiced	**Frequency**	**Percentage**	**Frequency**	**Percent**
Crop diversification	92	85.19	102	70.34
Off farm activities	70	64.81	119	82.07
Use of improved varieties	83	76.85	129	88.97
Multiple planting dates	73	67.59	34	23.45
Increasing farm size	64	59.26	69	47.59
Mulching	13	12.04	65	44.83

Farm plots fragmentation	47	43.52	32	22.07
Changing farmland	51	47.22	40	27.59
Livestock ownership	10	9.26	19	13.10

Source: Computed from Field Survey Data, 2018

Multiple responses

C. Constraints to Cassava Farmers' Adaptation Strategies

Adaptation constraints are factors that make it harder to plan and implement adaptation actions [23]. In other words, constraints are the limitations farmers faced in adopting strategies to cope with climate change and its vulnerable effects on cassava production and the wellbeing of the farmers. Adaptation constraints restrict the variety and effectiveness of options for actors to secure their existing objectives or for a natural system to change in ways that maintain productivity or functioning. These constraints commonly include lack of resources (e.g., funding, technology, or knowledge), institutional features that impede action, or lack connectivity and environmental quality for ecosystems [24]. The constraints identified by the cassava farmers in the study area, as revealed in Table 27, were; insufficient access to and awareness about the program on climate change adaptation (96.7%), inadequate access to weather and climate forecast information (83.3%), high cost of improved crop varieties (74.7%), high cost of irrigation facilities (11.5%), cost of labor (74.7%), low level of education of the farmers (70.0%), inadequate farm size (58.7%), increase in pest and diseases outbreak (53.3%), poor information on early warning systems (44.3%), tedious nature of climate change adaptation strategies (63.0%), involvement in some off-farm jobs (64.3%), poor agricultural extension service delivery (52.0%), poor access to and control of land (59.70%), loss of land due to erosion (65.7%) and low-income level (64.0%).

Insufficient access to and awareness about the programme on climate change adaptation (96.7%), inadequate farm size (86.7%), inadequate access to weather and climate forecast information (83.3%) are the leading constraints to adaptation strategies. The result is in line with [25]; [26]. Also, [27] noted that most farmers informed about science and climate change are able to overcome the effects of climate change because they are able to adapt to strategies. An increase in pest and diseases outbreak, involvement in some off-farm jobs, and low-income level are also constraints faced by the cassava farmers in adapting strategies to combat climate change. The low income earned by the farmers and the fear of crop failure has caused them to diversify to other sources of income which invariably taken most of their useful time and resources, thus not able to adopt strategies to adapt to climate change and its vulnerability effects. This is in accordance with [28], who noted that income is a major determinant of the adoption of adaptation strategies.

Access to weather information is very vital in helping farmers to plan ahead against any unexpected outcome on their farms as well as in reducing shock effects [29]. Inadequate weather information, ranked third, was also perceived as a serious concern due to the ineffective flow of weather information between the Metrological Services Department (MSD) and Federal Ministry of Agriculture and Rural Development (FMARD) before reaching the farmers. Related studies indicated that ideally, effective correspondence between FMARD and MSD would enhance well-integrated data for monitoring weather conditions and providing appropriate predictions for risk assessment [30]. Poor access to and control of land is also considered a serious constraint because most of the farmlands belong to families, communities, or the government, hence preventing farmers from committing resources into farmland management. Information gathered indicated that, for fear of losing farmland due to land ownership issues in the study area, farmers mostly do not risk improving the fertility of the land.

The analyses showed that the high cost of inputs as a result of the importation of most agricultural inputs, including improved varieties, irrigation equipment, fertilizer, weedicides, and insecticides, affect cassava farmers' purchasing power. As climate change adaptation entails a direct or indirect cost, opinions gathered revealed that most farmers in the study area perceive high input cost as a setback to adaptation. Research findings revealed that high input cost prevents poor cassava farmers from accessing the needed farm inputs for climate change adaptation [31]. This is similar to a study by [32] which asserted that as a result of poor climatic conditions in Northern Ghana, farmers have resorted to using improved groundnut seeds as an adaptation strategy; however, the high cost of the purported improved seed compelled most farmers to use unimproved seeds from local the market.

Inadequate extension officers coupled with a lack of logistics gave rise to poor extension services delivery. Similarly, the abysmal performance of extension officers in southwest Nigeria is a result of the poor farmer-extension officer ratio (1:3000), which is higher than that proposed by the World Bank (1:1500) [30]. This invariably undermines the dissemination of information to farmers and the organization of farm demonstrations to improve adaptation skills. Intercontinental studies of agricultural extension officers' training and resourcing have indicated that extension officers in Africa are poorly trained and under-resourced [33]. The research also indicated that loss of land was considered a constraint because soil erosion which is a direct effect of climate change, cannot support an adaptation strategy such as agroforestry, which takes a long period to improve soil fertility. Loss of land and fertility prevents any strategy that allows protecting the land and the soil [34]. According to the responses from the discussions, some farmers have resorted to acquiring a loan to purchase fertilizer to boost their yield instead of using compost and agroforestry practices, which take some time before improving the soil fertility.

Table 3: Distribution of Respondents according to Constraints to Climate Change Adaptation Strategies

Constraints	Frequency	Percentage	Rank
Insufficient access and awareness about programme on climate change adaptation	290	96.7	1st
Inadequate access to weather and climate forecast information	250	83.3	2nd
Cost of labour	224	74.7	3rd
High cost of improved crop varieties	220	73.3	4th
Low level of education of the farmers	210	70.0	5th
Involvement in some off farm jobs	193	64.3	6th
Low income level	192	64.0	7th
Tedious nature of climate change adaptation strategies	189	63.0	8th
Poor access to and control of land	179	59.7	9th
Inadequate farm size	176	58.7	10th
Increase in pest and diseases outbreak	160	53.3	11th
Poor agricultural extension service delivery	156	52.0	12th
Poor information on early warning systems	133	44.3	13th
Loss of land due to erosion	110	36.7	14th
High cost of irrigation facilities	35	11.5	15th

Source: Computed from Field Survey Data, 2018

Multiple responses

Conclusion and Recommendation

The study further concluded that cassava farmers in the savannah AEZ adopted adaptation strategies to climate change more than their counterparts in the rain forest AEZ and many constraints to climate change adaptation strategies were identified in the study area. Arising from this, it is therefore recommended that farmers should be willing to embrace different adaptation strategies to climate change that would bring about an increase in their scale of operation as most of the cassava farmers in the study areas cultivated less than 2 hectares of land for cassava production and Farmers, via extension agents, should be encouraged to practice multiple adaptation strategies because the resulting crop enterprise yield high profit per hectare.

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