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Climate-Smart Agriculture: Adaptation Option of Climate Change among Arable Crop Farmers in Owode Local Government Area of Ogun State, Nigeria.

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Abstract

Global climate change threatens agriculture, especially in developing nations like Nigeria. Climate Smart Agricultural Practices (CSAPs) were examined as climate change adaptation techniques for arable crop producers in Owode, Ogun State, Nigeria. A multi-stage sampling technique randomly chose 120 farmers. Survey data was analysed using frequency counts, averages, percentages, Chi-square, and Pearson's Moment Correlation. Mixed cropping, herbicide/insecticide use, crop rotation, cover cropping, organic fertiliser use, and mulching were among the CSAPs respondents most commonly employed. Friends and family (79.2%) and radio and television (78.3%) were CSAPs' primary information sources. There was a substantial correlation ($p<0.05$) between CSAPs usage and respondents' problems ($r= 0.239^{**}$, $p=0.008$). A statistically significant correlation ($p<0.01$) exists between CSAPs use and respondents' age ($r=-0.364^{**}$), farm size ($r=0.381^{**}$), and average annual income ($r=0.332^{**}$). Insufficient government assistance, capital intensiveness, and CSAPs technical information were significant impediments. The report recommends more government and stakeholder input and technical knowledge to encourage CSAPs.

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Introduction

Climate change is a vast reality that affects all sectors across all spheres of human activity. Still, the agricultural sector in developing countries like Nigeria is challenging. This challenge could result from low adaptive capacities to climate change of smallholder farmers and their reliance on rain-fed agriculture. In addition, the vulnerability in this part of the world is due to its ecological fragility, abject poverty, institutional weakness and political instability, now aggravated by climate change (Legess *et al.*, 2012). Also, many African nations' economies depend on sectors vulnerable to climate conditions, such as agriculture, fisheries, forestry and tourism (Below *et al.*, 2010). Therefore, promoting CSA is critical for African countries (Shittu *et al.*, 2021). Climate change is a global phenomenon undermining the efforts towards achieving the Sustainable Development Goals (Ume *et al.*, 2021). It is a reality in Nigeria as elsewhere in the world, especially in Nigeria, which is bounded by natural forces of their actions catalysed by climate change (Federal Ministry of Environment, 2020). The country's climate

has been changing, evident include an increase in temperature, variable rise in sea level, flooding, drought and desertification, land degradation, more frequent extreme weather events, affected forest water resources and loss of biodiversity (Elisha *et al.* 2017). Elisha *et al.* (2017) asserted that natural processes and anthropogenic activities cause climate change. In tackling the effects of climate change on agriculture, CSA has been identified as a way to ensure adaptation to the global issue through Climate Smart Agricultural Practices- CSAPs (Fawole & Aderinoye-Abdulwahab, 2021). The practices are fundamental remedies in alleviating poverty, food and nutritional insecurity by improving agricultural output plus incomes of farm families (Waaswa *et al.,* 2021). CSA encourages important enabling activities that can translate into better productivity and a friendlier environment (Fawole & Aderinye-Abdulwahaab, 2021). Examples of CSAPs, as cited in Waaswa *et al.* (2021), are drought-tolerant and high-yielding crop varieties, synthesis fertilisers, rainwater harvesting and storage, agroforestry, irrigation, mulching, composting, terracing, potato apical rooted cuttings (potato seedlings), potato mini tubers, crop rotation, intercropping, drainage management and minimum tillage. The CSA options generally integrate traditional and innovative practices, technologies, and services relevant to particular locations to adopt climate change and variability (International Centre for Tropical Agriculture-CIAT, 2014).

At the national level, considerable progress has been made in promoting CSA in Africa. At the same time, the Economic Community of West African States-ECOWAS supported mainstreaming CSA into the ECOWAP/CAADP programs (ECOWAS 2015). Also, there is evidence of the authorisation of governments to support at least twenty-five million farming households to adopt Climate Smart Agriculture (CSA) by 2025 (African Climate Smart Agriculture Summit, 2014). In Nigeria specifically, research institutions and colleges owned by the federal government are working on CSA to make their contributions to the fight against climate change-related problems (FAO & ICRISAT 2019).

Farmers' access to knowledge on CSAPs is critical in developing their adaptive capacities for climate change adaptation. The involvement of agricultural extension systems in effectively playing this role depends on several crucial factors, including the knowledge of extension personnel (Olorunfemi *et al.*, 2012) on CSA. While the government, establishments, and colleges are working to achieve the goals of sustainable development in the face of climate change by training farmers and government extension agents providing flexible loans and inputs, farmers should also try to contribute their quotas by practising sustainable agricultural practices such as climate-smart agriculture and refraining from activities that aggravate the current state of the climate. Several research works have been carried out on agriculture and the climate, specifically on farmers' perception of CSA (Terdoo, 2020) and adoption of CSA (Tiamiyu *et al.*, 2017; Abegunde *et al.* (2020); Onyeneke *et al.* (2021) and willingness to pay for CSA (Shittu *et al.* 2021; Anugwa *et al.*, 2021). As a result, it is critical to look into the scope of using CSAP. The study's goals are to (a) identify farmers' sources of CSAPs information, (b) determine the extent of practice of CSAPs in the study area, and (c) examine the problems confronted in practising CSA. The study hypothesised that (a) there is no significant relationship between CSAPs and the selected socioeconomic characteristics of the respondents and (b) there is no significant relationship between CSAPs challenges encountered by the respondents.

Methodology

Study Area

Ogun State was created from the old western region on February 3rd, 1976. Geographically, the state lies within latitudes 6° 12'N and 7 ° 47'N in the tropics and longitudes 3 ° 0'E and 5 °0' east of the Greenwich meridian (Adeleke *et al.*, 2015) (Figure 2). The state covers 16,409.26 kilometres and shares an international boundary with the Republic of Benin to the West and interstate boundaries with Oyo State to the north, Lagos and the Atlantic Ocean to the South and Ondo State to the east. The state is located in a moderately hot, humid tropical climatic zone of Southwest Nigeria. The climate of Ogun State follows a tropical pattern with two distinct seasons (the rainy season lasts from March/ April to October/ November till March/ April). The annual rainfall of the State value ranges

between 1,400mm and 1500mm with an average temperature of 30°C). The humidity is lowest at the peak of the dry season in February, usually at 37-54% and highest between June and September, with a value of 78-85% (Adeleke, 2015). Ogun State has two main types of vegetation: tropical rainforests and guinea savannah.

Data collection, measurement and analysis

The study employed a questionnaire method of data collection. A questionnaire is a research instrument consisting of a set of questions (items) intended to capture responses from respondents in a standardised manner (Anol, 2012). The questionnaire was designed in phases to capture questions on the sources of information on CSAPs, the extent of practice and the challenges encountered by the farmers. A dichotomous variable of 'yes or no' was used to measure the sources of information and CSA practised in the study area. The extent of the practice of CSA was measured on a four-point rating scale of Very Often (VO), Often (O), Rarely (R) and Never (N). The extent of the practice of CSAPs was categorised into high and low usage as follows:

Categorisation of the extent of usage of CSAPs = Min. + Max. Obtainable score/category number (that is, 14+56/2= 35). The respondents were categorised as low usage (14-35) and high usage (36-56)

Also, challenges encountered by the respondents were measured on a 3-point rating scale of 'Major constraint (Mac), Minor constraint (Mic) and Not a constraint (N). The aggregate of the raw scores was used to calculate the mean scores for each response, as adapted from Adebayo and Ojogu (2019).

The data obtained were analysed using Statistical Package for Social Sciences window version 23. The analytical tools employed in this study were descriptive statistics (percentages, tables, frequency counts and means) and inferential statistics (Chi-square and Pearson's Product Moment Correlation).

Results and Discussion

Socioeconomic characteristics of the respondents

The results on socioeconomic characteristics are presented in Table 1. Results show that approximately half of the respondents were between 41 and 60, with a mean age of 42.11 years. This age range suggests that the farmers were active and could practice CSAPs. The respondents in this study were younger than what (47.87%) was reported by Adeagbo *et al.* (2021) and Faleye and Afolami (2020), who reported an average age of 50 years in a study conducted on adaptation to climate change in southwest Nigeria. This study surveyed 63.3 per cent of male and 36.7 per cent of female farmers. This means that more male farmers practised CSAPs in the study area. This report is similar to Ige *et al.'s (2020) study* on adaptation to climate change.

Furthermore, 47.5%of the respondents were married, which could signify family labour availability, corroborating the findings of Faleye and Afolami (2020) in their study on the determinants of the choice of climate-smart agriculture practices adoption among yam-based farming households in Ogun State, Nigeria. The findings also revealed the presence of three religious groups among the respondents. The results show that most respondents possessed one form of formal education (95%). This finding corroborates the report of Shittu *et al.* (2021) in their study on the analysis of farmers' adoption of Climate Smart Agricultural Practices in Northern Nigeria. Most (92.5%) respondents cultivate less than 6 ha of farmland, with a mean of 2.5ha, indicating that the respondents were small-scale farmers. This report is in tandem with Obi-Egbebi and Oladapo (2020) in their study on 'Do climate-smart agricultural practices drive food security of maise farming households in Ogun State, Nigeria' where the respondents cultivated an average of 1.8 hac farmland. The results also show that the majority (82.2%) earned less than 500,001 naira per annum. This shows that the respondents earn less than 50,000 naira per month. This could suggest that the farmers were smallholder farmers, as confirmed by the mean cultivated land of 2.5ha. In addition, the respondents had 16 years of experience in farming, suggesting that the respondents had been experiencing changes in climate for almost two decades.

Sources of information on CSA practices

Results in Figure 1 show that the respondents obtained information on CSAPs from different sources. Most farmers obtained information on CSAPs through friends and family (79.2%) and radio and television (78.3%). This indicates that friends and family and radio are the most accessible sources of

social capital for spreading climate change adaptation information. This result is similar to the findings of Adebayo and Ojogu (2019), who reported that most of their respondents often obtain information on CSAPs from fellow farmers, family, friends, and radio in a study conducted in Ogun State. However, more than half of the respondents obtained information from social organisations (55.5%), while extension agents (35%) and NGO sensitisation (35%) were the least. The findings indicate that information about CSAPs is available from various sources. According to this study, however, extension contact on CSAPs is poor. This is supported by the percentage of extension visits (15.85%) obtained in this study. The result corroborates the finding of Owombo *et al.* (2013), who obtained extension visits of less than 10% in their study of adaptation to climate change.

Table 1: Socioeconomic characteristics of the respondents

Socioeconomic characteristics	Frequency	Percentage (%)	Mean ($\bar{X}$)
Age (years)			
>21	4	3.3	
21-40	50	41.7	
41-60	61	50.8	42.11years
61-80	5	4.2	
Sex			
Male	76	63.3	
Female	44	36.7	
Marital Status			
Single	39	32.5	
Married	57	47.5	
Widowed	12	10.0	
Separated/divorced	12	10.0	
Religion			
Christianity	66	55.0	
Islam	42	35.0	
Traditional	12	10.0	
Educational level			
No formal education	6	5.0	
Formal education	114	95.0	
Extension contact	19	15.8	
Farm size (ha)			
0-5	111	92.5	2.5ha
6-10	5	4.2	
11-15	0	0.0	
16-20	4	3.3	
Income (₦)			
0-500,000	99	82.5	₦ 307,000.00
500001-1,000,000	21	17.5	
Farming experience (years)			
> 10	53	44.2	
11-20	33	27.5	16years
above 20	34	28.3	

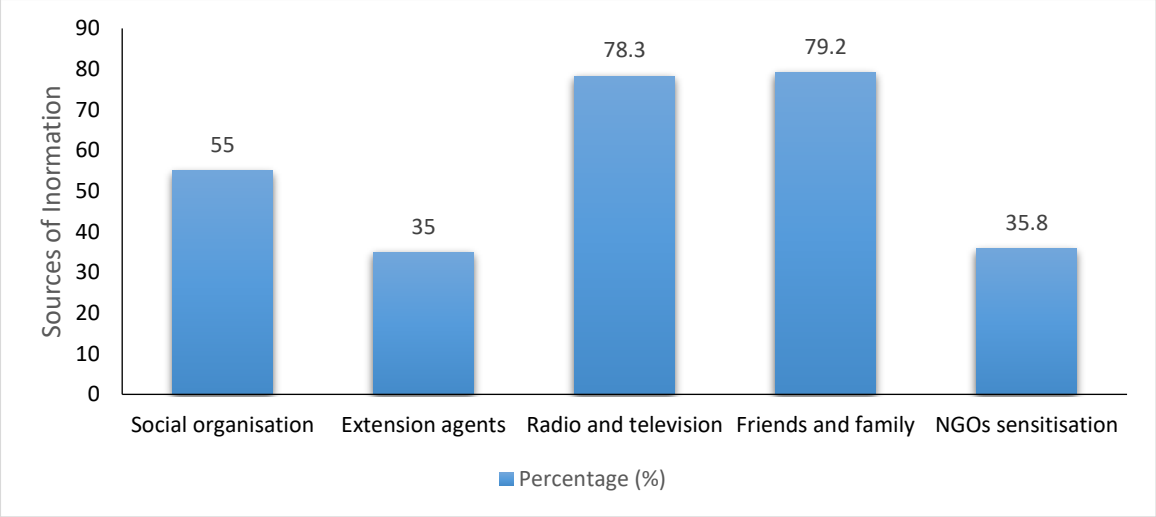

Fig 1: Sources of information on CSA practices (n=120)
Source: Field survey, 2021

CSA adopted and practised by the respondents

Results in Table 3 show the significant CSAPs adopted and practised by the respondents. The majority of the respondents practised mixed cropping (93.3%), application of inorganic manure (85%), crop rotation and cover cropping (78.3%), minimum tillage (75.8%), mulching (73.3%), and application of inorganic fertiliser (71.1%). Except for inorganic fertiliser application, these findings indicate that the prevalent CSAPs embraced and practised by farmers are conventional techniques of maintaining environmental sustainability. These have existed before the public awareness of climate change, yet they are CSAPs. This study is consistent with Terdoo and Adekola (2014), who asserted that farmers have previously accidentally practised CSA as part of their chronic farming system in Nigeria. Planting of drought-resistant varieties was the least popular CSAP (45.8 per cent) in the study area. The low adoption could be attributed to a lack of improved seed/seedlings and the short duration of the drought as compared to the Northern part of the country. Terraces were also used by 48.3 per cent of farmers, which is mainly dependent on the terrain of their farmland. The result is similar to the findings of Adesiji *et al.* (2014), Tiamiyu *et al.* (2017), Onyeneke *et al.* (2018), and Adebayo and Ojogu (2019).

Table 3: Major CSA adopted and practised by the respondents (n=120)

CSAPs adopted	Frequency	Percentage (%)
Mixed cropping	112	93.3
Agroforestry (planting of crops in between trees)	59	49.2
Mulching	88	73.3
Use of organic manure/green manure	102	85.0
Planting of drought-resistant varieties	55	45.8
Use of cover crops	94	78.3
Use of wetlands	77	64.2
Planting of early maturing varieties	75	62.5
Tillage/minimum tillage	91	75.8
Irrigation	82	68.3
Crop diversification	69	57.5
Erection of terraces on sloping/hilly farmland	58	48.3
Use of Inorganic fertiliser	86	71.7
Crop rotation	94	78.3
Use of herbicides/pesticides	99	82.5

Source: Field survey, 2021

The extent of usage of the CSAPs

Table 4 shows the extent of the use of different CSAPs to offset the effects of climate

change. All respondents scored higher than the mean ($\bar{x}$ = 2.50), indicating that the respondents are familiar with the CSAPs reviewed in this study. The results in Figure 2 revealed that the CSAPs were also widely used by the respondents. This result follows the observations of Adebayo and Ojogu (2019) and Olorunfemi *et al.* (2021), who reported high usage (above 70%) of cover crop, mulching and crop rotation in a study conducted in southwest Nigeria.

Table 4: Extent of usage of the CSAPs

CSAPs	Very often	Often	Rarely	Never	Mean ($\bar{x}$)	Rank
Mixed cropping	77(64.2)	32(26.7)	5(4.2)	6(5.0)	3.50	1st
Use of herbicides/pesticides	61(50.8)	40(33.3)	15(12.5)	4(3.3)	3.31	2nd
Crop rotation	57(47.5)	45(37.5)	13(10.8)	5(4.2)	3.28	3rd
Use of cover crops	49(40.8)	45(37.5)	19(15.8)	7(5.8)	3.13	4th
Use of organic manure	39(32.5)	63(52.5)	11(9.2)	7(5.8)	3.11	5th
Mulching	45(37.5)	45(37.5)	24(20.0)	6(5.0)	3.07	6th
Tillage/minimum tillage	36(30.0)	48(40.0)	24(20.0)	12(10.0)	2.90	7th
Irrigation	41(34.2)	39(32.5)	24(20.0)	16(13.3)	2.87	8th
Use of Inorganic fertiliser	37(30.8)	39(32.5)	32(26.7)	12(10.0)	2.84	9th
Drought resistant varieties	34(28.3)	41(34.2)	27(22.5)	18(15.0)	2.75	10th
Early maturing crop varieties	37(30.8)	34(28.3)	30(25.0)	19(15.8)	2.74	11th
Use of wetlands	35(29.2)	37(30.8)	29(24.2)	19(15.8)	2.73	12th
Agroforestry	26(21.7)	47(39.2)	33(27.5)	14(11.7)	2.70	13th
Construction of terraces	29(24.2)	37(30.8)	31(25.8)	23(19.2)	2.60	14th

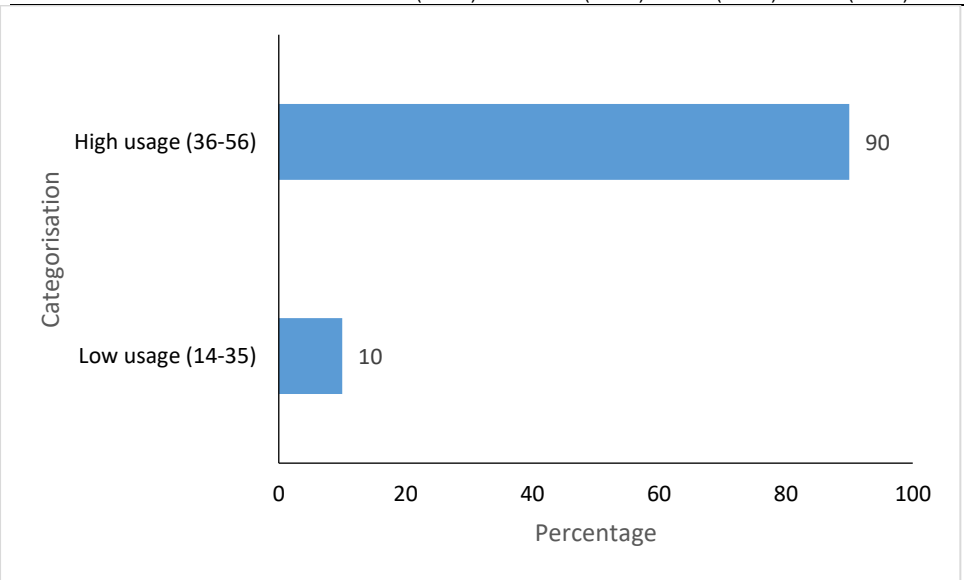

Fig 2: Categorisation of the extent of usage of CSAPs

Challenges faced by the farmers in practising CSAPs

The challenges faced by the respondents are presented in Table 6. Based on the means obtained, the obstacles experienced by respondents in the practice of CSAPs include inadequate government support for CSAPs (= $\bar{x}$ 2.71) and capital intensiveness of CSAPs ($\bar{x}$ = 2.50), non-availability of improved seeds ($\bar{x}$ = 2.46), and insufficient access to technical information ($\bar{x}$ = 2.45), insufficient training on modern CSAPs ($\bar{x}$ =2.39), scarcity of labour ($\bar{x}$ = 2.31), limited skills on CSAPs ($\bar{x}$ = 2.09) and lack of knowledge on modern CSAPs ($\bar{x}$ =2.07). The findings suggest that these challenges must be addressed if the goals of CSAPs are to be met. This result is similar to Onyeneke's (2018) and Adebayo and Ojogu (2019) reports

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Table 6: Challenges faced by the farmers in practising

Challenges faced by the respondents	Major challenge	Minor challenge	Not a challenge	Mean ($\bar{x}$)	Rank
Limited government support for CSA practices	94(78.3)	17(14.2)	9(7.5)	2.71	1st
Capital Intensive	65(54.2)	50(41.7)	5(4.2)	2.50	2nd
Non-availability of improved seed	75(62.5)	26(21.7)	19(15.8)	2.46	3rd

Inadequate access to technical information	65(54.2)	45(37.5)	10(8.3)	2.45	4th
Insufficient training on modern CSAPs	59(49.2)	49(40.8)	12(10.0)	2.39	5th
Scarcity of labour	48(40.0)	62(51.7)	10(8.3)	2.31	6th
Limited skills in CSAPs	33(27.4)	65(54.2)	22(18.3)	2.09	7th
Lack of knowledge of modern CSAPs	36(30.0)	57(47.5)	27(22.5)	2.07	8th

Source: Field survey, 2021

Relationship between the Extent of Usage of CSAPs and Socioeconomic Characteristics

Results on the relationship between the extent of CSA practice and the respondents' socioeconomic characteristics are presented in Table 7.

According to the table, there was no statistically significant connection ($p>0.01$) between the extent of use of CSAPs and marital status ($\chi^2= 7.290$), educational level ($\chi^2= 7.290$), access to credit facilities ($\chi^2=0.448$) and extension contact ($\chi^2= 0.563$). According to the findings, the degree of CSAP practice is not significantly related to marital status, educational level, and access to credit facilities, implying that an increase in these variables does not translate to an increase in the extent of the practice of CSAPs. However, there is a strong relationship between respondents' level of use of CSAPs and sex, implying that sex influences the extent of usage of a particular CSAP.

Table 7: Test of the relationship between the extent of CSA practice and the respondents' socioeconomic characteristics.

Socioeconomic characteristics	χ^2	Df	p-value	Decision
Sex	4.609	1	0.032	S
Marital Status	7.290	4	0.121	NS
Educational level	7.892	5	0.162	NS
Access to credit facilities	0.448	1	0.503	NS
Extension contact	0.563	1	0.453	NS

Source: Field Survey, 2021
NS=Not Significant; S= Significant

Relationship between the Extent of Practice of CSA and Sources of Information.

The result of the relationship between the extent of Practice of CSA and Sources of Information is presented in Table 9. Results showed a statistically significant relationship ($p<0.05$) between the extent of the practice of CSA and age ($r=-0.364^{**}$), farm size (0.381^{**}), average annual income and practice of CSA.

This indicates that CSAPs increase with a farmer's age, implying that older farmers are more likely to use CSAPs than younger farmers; this could result from the fact that the CSAPs reviewed in this study are indigenous methods of mitigating the consequences of climate change. This could suggest that older farmers could learn more about using CSAPs. Also, increasing farm size could improve the likelihood of implementing additional CSAPs. Furthermore, as average annual income rises, farmers can buy farm inputs, pay labourers, expand their farming operations, and implement more CSAPs. The implication is that these three factors are crucial in enhancing farmers' capacity to adjust to climate change and increase production.

Table 9: The relationship between sources of information and the extent of Practice of CSA.

Variable	r-value	p-value	Decision
Sources of information and extent of the practice of the CSA	0.351^{**}	0.000	S

Source: Field Survey, 2021; S=Significant

The table results reveal a statistically significant association between the level of CSA practice and the sources of information. This implies that how information is gathered is proportional to the level to which CSA is being practised. This means that farmers with access to various CSA information sources are more likely to practice more. This result is similar to the findings of Adebayo and Ojogu

(2019) in a study conducted on CSAPs in Ogun State.

Relationship between the Extent of Practice of CSA and Challenges Encountered by the Respondents.

The results in Table 10 show the relationship between the extent of use of CSAPs and the challenges encountered by the respondents. The table shows a significant link ($p< 0.01$, $r=0.239^{**}$) between the level of CSA activity and the farmers' challenges. This indicates a statistically significant and direct association. This suggests that the greater the obstacles farmers face, the more likely they can implement various CSAPs.

Table 10: Test of the relationship between the extent of the practice of the CSA and challenges faced by the farmers

Variable	r-value	p-value	Decision
Challenges faced by the farmers in practising CSA and the extent of the practice of CSA	0.239**	0.008	Significant

Source: Field Survey, 2021

Conclusion and recommendations

The study focused on climate-smart agricultural practices as an adaptation option to climate change in Owode, a local government area in Ogun State. According to the findings, CSAPs' primary sources of information were friends and family, radio and television, and social organisations. The implication is that these methods were effective avenues for disseminating climate change adaptation information. The respondents had high usage of CSAPs. This implies that the farmers adapted to climate change and ensured production despite the changing conditions.

On the other hand, the farmers faced some difficulties that needed to be handled. According to the study, the government should provide maximum support to farmers through agricultural extension agencies, sensitise them, and give them the necessary training and skills to improve their ability to use CSA. In addition, extension agents' activities should be strengthened so that their impact on farmers is felt more in their contact with them. Furthermore, the Nigerian government should assist in subsidising enhanced seeds/seedlings of early-maturing crops and drought-resistant varieties.

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