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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Farmers' adaptation strategies to mitigate climate impacts on cocoa production: experience from Osun State, Nigeria

Çiftçilerin kakao üretimi üzerindeki iklim etkilerini azaltmak için uyum stratejileri: Nijerya'daki Osun Eyaletinden deneyim

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ABSTRACT

The study assessed cocoa farmers' adaptation strategies for mitigating impacts of climate change on cocoa production in Osun State, Nigeria. It profiled socio-demographic features of cocoa farmers, examined impacts of climate change; determined utilisation of adaptation strategies and examined the barriers to their usage. Data were drawn from 120 cocoa farmers across the state using interview schedule. Appropriate statistical tools were employed to analyse the primary data collected. The findings showed that most of the cocoa farmers (87.5%) were male with a mean age of 54.1± 10.8years. All (100%) cocoa farmers indicated high awareness of climate change. The findings showed that climate change retarded growth of cocoa seedlings and reduced cocoa yield. Key adaptation strategies utilized were planting of shade trees and frequent spraying of cocoa with pesticides. Majority of the cocoa farmers indicated high level of usage of different climate change adaptation strategies. High cost of inputs and unpredictable weather were the major barriers limiting the usage of adaptation strategies. Age (r=-0.501) and years of engagement in farming (r=0.551) were significantly related to the utilization of adaptation strategies. The research concluded that cocoa farmers utilized multiple adaptation strategies at high level to mitigate impacts of climate change to enhance sustainable and optimum cocoa production in Nigeria.

ÖZET

Çalışma, Nijerya'nın Osun Eyaletinde iklim değişikliğinin kakao üretimi üzerindeki etkilerini hafifletmek için kakao çiftçilerinin adaptasyon stratejilerini değerlendirdi. Kakao çiftçilerinin sosyo-demografik özelliklerinin profilini çıkardı, iklim değişikliğinin etkilerini inceledi; uyum stratejilerinin kullanımını belirlemiş ve kullanımlarının önündeki engelleri incelemiştir. Veriler, görüşme programı kullanılarak eyaletteki 120 kakao çiftçisinden elde edilmiştir. Toplanan birincil verileri analiz etmek için uygun istatistiksel araçlar kullanılmıştır. Bulgular, kakao çiftçilerinin çoğunun (%87.5) erkek olduğunu ve ortalama yaşlarının 54.1± 10.8 olduğunu gösterdi. Tüm (%100) kakao çiftçileri, iklim değişikliği konusunda yüksek farkındalığa sahiptir. Bulgular, iklim değişikliğinin kakao fidelerinin büyümesini geciktirdiğini ve kakao verimini azalttığını ifade etmiştir. Kullanılan temel adaptasyon stratejileri ise, gölge ağaçların dikilmesi ve kakaoya sık sık böcek ilacı püskürtülmesi ugyulamalarıdır. Kakao çiftçilerinin çoğunluğu, farklı iklim değişikliği uyum stratejilerini yüksek düzeyde kullandıklarını belirtmişlerdir. Girdilerin yüksek maliyeti ve öngörülemeyen hava koşulları, uyum stratejilerinin kullanımını sınırlayan başlıca engellerdi. Yaş (r=-0.501) ve çiftçilikle uğraşma yılı (r=0.551) uyum stratejilerinin kullanılmasıyla anlamlı şekilde ilişkilidir. Araştırma, kakao çiftçilerinin Nijerya'da sürdürülebilir ve optimum kakao üretimini artırmada, iklim değişikliğinin etkilerini azaltmak için yüksek düzeyde birden fazla uyum stratejisi kullandığı sonucuna varılmıştır.

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INTRODUCTION

Cocoa is one of the key cash crops and leading export crop that contribute a lot to revenue to Nigerian government which accounted for about 50 percent of total export earnings between 1950s and 1960s before the discovery of oil (Agronews Nigeria, 2017). According to Shahbandeh (2023), Nigeria is one of the five leading cocoa producing countries in the world and fourth largest cocoa producer in West Africa with total production of 280 metric tons of cocoa beans in 2022. Cocoa is currently cultivated in eighteen states Nigeria on a total land area of 1,363.60 hectares (ha) scattered over all the country with an annual production of 280,000 metric tonnes of cocoa beans (FAOSTAT, 2022; Afolayan, 2020). Cocoa production in Nigeria is dominated by smallholder farmers scattered all over 18 cocoa producing states in Nigeria (Rainforest Alliance, 2017).

Cocoa production is one of the important source of income generation to farmers both on small or large scale and remains a critical source of livelihood to rural dwellers especially in fourteen cocoa producing states in Nigeria. Cocoa is very sensitive to climatic condition of the environment where it is planted right from the nursery to permanent site. Hours of sunshine, temperature, soil conditions and particularly amount of rainfall and other climatic factors to an extent have effects on cocoa production (Oyekale et al., 2015). Climate change phenomenon refers to long-term seasonal variations caused by the atmosphere's increasing concentration of greenhouse gases. While climate variability refers to the natural processes that affect the atmosphere and also results to climate change. Most parts of world have experienced global warming in terms of high temperatures, marked change in pattern of rainfall, warming of coastal waters and an increase in frequency and intensity of storm. Smallholder farmers in Nigeria are particularly vulnerable to climate change impacts because majority of their agricultural production depend on rainfall. The impact of climate change on cocoa production are very obvious, severe and devastating in Nigeria as its resulted into declining and fluctuation in cocoa production annually due to greater dependence on climatic factors which does not encourage commercialization of agriculture (Clements et al., 2011). According to Gateau-Rey et al. (2018) who reported that by 2050, there is possibility of less land suitable for growing cocoa this is based on a climate change model for West African cocoa production. Surprisingly, this decrease will be caused by increased temperatures. Since cocoa is highly sensitive to drought and thrives well with water availability, it also requires relative high temperature and rainfall that is evenly distributed throughout the year. Reducing vulnerability means using sustainable adaptive strategies incorporated with traditional and indigenous knowledge which can be technology transfer, policies formation and increasing the adaptive capacities of the small holder farmers who produce most of the food supply in the country. The level of farmers' vulnerability to the effect of climate change can be measured by impact of climate change (Obaniyi et al., 2019). In fact, Notre Dame Global Adaptation Index (ND-GAIN) (2021), ranked Nigeria 53rd among most venerable countries in the world. Since climate is changing, and mitigation measures to improve sinks or decrease sources of greenhouse gases is very important to safeguard subsistence farmers from to the negative effects of climate change on their production, this necessitates the need to adopt suitable mitigation and adaptation strategies to cushion the effects of climate variability on cocoa production. Alemu & Desta, (2021) observed that cocoa farmers have been forced to develop adaptive strategies to mitigate these effects. Some of these strategies adopted are use of fertilizers, pruning of older cocoa tree, changing cropping pattern, use of pesticide and herbicide among others.

Extant literature on climate change such as Okeniyi et al. (2021), Obaniyi et al. (2019) and Falola & Fakayode (2014) revealed that cocoa farmers exhibited high level of awareness of climate change on their crops; observed that annual fluctuations in the yield was as a result of rainfall; and that most of the cocoa farmers adopted spraying of agrochemicals like pesticides and fungicides, diversifying into other livelihood activities, mixed cropping and planting of improved varieties and among others. Despite the fact that Osun State ranked second among cocoa producing states in Nigeria with about 70,000 tonnes production capacity in 2020 (Nigeria Informer, 2023); and had been experiencing the incidence of climate change and its attendance impact on cocoa; there is still an inadequate

empirical data on cocoa climate change adaptation strategies in Osun State, Nigeria. Hence, the need for this study. In view of this, this research was conceived to profile the socio-demographic features of cocoa farmers; examine the climate change impact on cocoa; determine the adaptation strategies utilized and examine the barrier to their utilization. Two hypotheses set for this study were: there is no significant relationship between socio-demographic features and utilization of adaptation strategies, and there is no significant relationship between impact of climate change and utilization of adaptation strategies.

MATERIALS and METHODS

Study area

The study was executed in Osun State, Nigeria between March 2021 and September 2021. The State was made up of thirty Local Government Areas (LGAs). Residents of Osun state are predominantly of the Yoruba ethnic group with some Igbo, Hausa and few Fulani ethnic groups. The study was carried out in the three ADP Agro-ecological zones namely: Oshogbo, Iwo and Ife/Ijesha.

Sampling technique

Sample selection was done through multistage sampling procedure. Six LGAs were purposively picked from the three ADP zones based on high prevalence of cocoa production in the two LGAs from each zone at the first stage. The chosen LGAs were Ede South and Boripe LGAs in Oshogbo zone; Aiyedaade and Ayedire LGAs in Iwo zone; while Ife East and Obokun LGAs were picked from Ife/Ijesha zone. At the second stage, two communities were randomly chosen from each LGA, making a total of twelve communities. The final stage involves random selection of 10% of cocoa farmers in all the selected communities which translated into Iyanfoworogi (13), Yekemi (12), Ilahun (11), Ipetu-Ile (10), Sekona (11), Akoda (9), Ada (9), Orooruwo (12), Oogi (10), Orile-Owu (8), Kuta (7) and Onigangan (8) farmers, making a total of 120 cocoa farmers. A structured interviews schedule was used to gather relevant data from smallholder cocoa farmers to achieve the research objectives. Data collected were analysed through percentages, means, chi-square and correlation analyses.

Measurement of variables

Utilisation of adaptation strategies was the dependent variable for this study. This was determined by asking cocoa farmers to indicate the extent of using adaptation strategies to cushion the impact of climate change on a four-point scale from always utilized (3) to not utilized (0) as used by Adisa et al. (2022) and Adeyemo et al. (2017). The bench mark of 1.5 was derived as adopted by Alabi et al. (2020). This was used to determine the climate change adaptation strategies mostly utilised. Adaptation strategy mean score of at least 1.5 based on the responses of the respondents was regarded as strategies mostly utilized strategies while those with adaptation strategy mean score of less than 1.5 were regarded as less utilized strategies. The equal interval method was used to categorize respondents to high and low levels of utilization from respondents' utilization score generated. The perceived impact of climate change on cocoa was determined by asking the respondents to respond to nine statements. Their responses were rated on a five-point Likert scale from Strongly Agree (5 points) to Strongly Disagree (1point) and reverse for negative statement. The total impact score was calculated and benchmark of 3 was obtained. This was used to determine major or minor perceived impacts of climate change on cocoa production. Perceived impacts of climate change with mean score of at least 3 were regarded as major perceived impacts while those with mean score less than 3 were regarded as minor perceived effect.

RESULTS and DISCUSSIONS

Socio-demographic features

Evidence in Table 1 show that the mean age of cocoa farmers was 54.1± 10.8years, suggesting that cocoa farmers were ageing and expected to aware change in climate based on their age, as age is one of the parameters for measuring experience. This could assist them in adopting adaptation strategies that could help in mitigating against climate change. However, this could have a negative implications on cocoa production since majority of them of were getting old, there is need for succession plan for young people to replace them This supports to the findings of Oyekale & Oladele (2012) and Oyekale (2020) which established that the average age of cocoa farmers in Southwestern Nigeria and Ghana are 55.01 and 51.7 years respectively. Majority (87.5%) of the respondents were males. This implies male domination of cocoa farming and this is expected because agricultural activities require a lot of energy and hazards which only male can cope with. This result is in line with Kosoe & Ahmed (2022) and Okeniyi et al. (2021) who reported that majority of cocoa farmers were predominantly males. The mean family size of the respondents was 6 ± 3 persons, indicating that cocoa farmers had a moderate family size, this could somehow influence and ease adoption of climate strategies because family members especially children are expected to provide labour for agricultural work. This supports to reports of Oyekale & Oladele (2012) that cocoa farmers in Southwestern Nigeria had an average family size of 7 persons. Further analysis in Table 1 show that majority (86.7%) of cocoa farmers had formal education where larger proportion (44%) of them attended more than primary schools. This implies that cocoa farmers had moderate level of education. This could assist them in making better decision in adopting appropriate adaptation strategies to mitigate the impact of climate change. This is concurs with findings of Gbigbi & Ndubuokwu (2022) who reported that high proportion farmers were reasonably educated which could influence their decision to use adaptation strategies. Majority (88.3%) practised farming as their primary occupation, 8.3% in trading and 3.3% engaged in other occupations aside farming. This implies that although cocoa farmers engaged in farming as their main source of livelihood, they still engaged in other sources of livelihood to augment their income. The mean of engaging in cocoa production was 29.3 ± 15.3 years, indicating that most of the respondents had greater experience in cocoa farming activities which could assist them to have better knowledge of cocoa farming and this could influence their adaptive capacity to cushion impacts of climate change on cocoa production. This supports Oyekale (2020), Elisha et al. (2017) and Agbongiarhuoyi et al. (2013) who reported that majority of cocoa farmers have enough years of experience in their occupation. Larger percentage (59.2%) of the respondents acquired their land through inheritance from the family while 34.2% obtained their cocoa land through leasehold or rent. The result implies that the majority of cocoa framers acquired their land through inheritance. This confirms the result of Famakinwa et al., (2017) who submitted that majority of smallholder farmers in Osun State acquired land through inheritance. The result reveals that cocoa farmers had farm size of 2.8 hectares. This reveals that most of the cocoa farmers in Osun State were subsistence farmers. This is agrees with submission of Agbongiarhuoyi et al. (2013) who reported that cocoa farmers had a mean farm size of 2.59 hectares but contrary to Oyekale & Oladele (2012) which reported a mean farm size of 7.9 hectares. All (100%) the respondents claimed that they were aware of climate change based on their past experiences and observations. This concurs to Kosoe & Ahmed (2022), Okeniyi et al. (2021) and Obaniyi et al. (2019) who established that cocoa farmers were aware of climate change occurrence based their past experience. This high awareness level of climate change issue would likely help them in knowing types of adaptation strategies to utilize to mitigate the effects of climate change on cocoa (Bayel & Salau, 2018). Further results show that cocoa farmers mostly heard about on climate change from co-farmers (99.2%), friends (97.5%), radio (95.8%), television, (52.5%), extension agents (51.7%) while the few farmers obtained information on farmer's association (40.8%), newspaper (35.8%) and metrological stations (30%). The results show that respondents had multiple means of accessing information on climate change, However, extension agents and metrological stations are the most reliable sources where

farmers can get detailed information that would assist them in planning and implementing measures to mitigate climate change effects on their farms. This is similar to the findings of Kosoe & Ahmed (2022) and Okeniyi et al. (2021) that majority of cocoa farmers obtained climate change information from Radio and few of them sourced information from extension agents. It is evident from this result that interpersonal communication (co-farmers and friends) and radio were the main sources of information where cocoa farmers got their information on climate change (Ogunjimi & Ifekuse, 2021).

Table 1. Respondents' socio-demographic features
Tablo 1. Katılımcıların sosyo-demografik özellikleri

Variables	**Frequency**	**Percentage**	**Mean**	**Std. Dev**
Age				
≤35	5	4.20		
36-65	101	84.20		
66≥	14	11.70	54.13	10.28
Sex				
Male	105	87.50		
Female	15	12.50		
Marital Status				
Single	2	1.70		
Married	103	85.8		
Widowed	10	8.30		
Separated	5	8.30		
Family size				
≤4	16	13.30		
5-7	92	76.70	6	3
8≥	12	10.00		
Educational level				
No formal education	16	13.30		
Primary education	51	42.50		
Secondary education	33	27.50		
Tertiary education	20	16.70		
Major Occupation				
Farming	106	88.30		
Trading	10	8.30		
Others	4	3.30		
Years of Farming Experience				
≤25	57	47.50		
26-55	55	45.80	29.33	15.24
56≥	8	6.70		
Methods of Land acquisition				
Inheritance	71	59.20		
Purchased	8	6.70		
Leased	41	34.20		
Farm Size (Hectares)				
≤4	95	79.20		
5-8	19	15.80		
9≥	6	5.00	2.80	1.27
5-8	19	15.80		
Awareness of climate change				
Aware	120	100		
Not aware	0	0		

Table 1 (continued). Respondents' socio-demographic features

Tablo 1 (devamı). Katılımcıların sosyo-demografik özellikleri

*Climate information sources		
Co-farmers	119	99.20
Friends/Neighbours	117	97.50
Radio	115	95.80
Television	63	52.50
Extension agent	62	51.70
Farmers' organization	49	40.80
Newspaper	43	35.80
Metrological stations	36	30.00

* Multiple responses

Climate change impact on cocoa production

Information presented in Table 2 show the physical manifestation of climate change on cocoa as ranked by the respondents; and based on the benchmark of 3, the result shows that majority of the cocoa farmers indicated that climate change had major effects in retarding growth of cocoa seedling due prolong drought (mean=3.86), reducing yield of cocoa due to prolong drought (mean=3.80), increasing susceptibility of cocoa to black pod disease due to excessive rainfall, and low temperature and high relative humidity (mean=3.78) among others. This agrees with the reports of Osei (2017) and Adeniyi et al. (2017) who submitted that climate change had the following effects on cocoa production: low yield, wilting of new cocoa trees, delay in maturity of the cocoa beans and increased in strange pests and diseases. This implies that cocoa farmers perceived that climate change had negative effects on cocoa production as drought, low rainfall and high temperature retard growth of cocoa seedlings, reduce yield, causes withering and dying off of new cocoa trees or seedlings and delay in flowering and poor fruiting of cocoa. Besides, excessive rainfall with very low temperature or no sunshine for a long period increases susceptibility of cocoa to black pod diseases of cocoa which account for larger percentage of yield loss in cocoa production (Okeniyi et al., 2021; Cilas and Bastide, 2020). This is due to the fact that these effects have negative influence on the quantity and quality of cocoa production. This result is in line with Oyekale and Oladele (2012) who stated that cocoa tree is sensitive to climatic condition of the environment it is planted right from the nursery to permanent site. Hours of sunshine, temperature, soil conditions and particularly amount of rainfall and among others to some extent have effects on cocoa production. The results is also due to the fact that farmers depend on rainfall for agriculture.

Table 2. Climate change impact on cocoa

Tablo 2. İklim değişikliğinin kakao üzerindeki etkisi

Variables	**Ranked mean**
Retard growth of cocoa seedling due drought	3.86
Low yield of cocoa due to drought	3.80
Increase in diseases due excessive rainfall and low temperature	3.78
Delay in flowering and poor fruiting of cocoa shortage of rainfall	3.68
Withering/dying of cocoa seedlings due to drought/high temperature	3.57
Increase in pests due prolong shortage rain	3.49
Delay in maturity of cocoa beans due shortage of rainfall	3.10
Resistance of pests and diseases to pesticides	2.20
Occurrence of unfamiliar diseases and pest	1.24
Loss of soil fertility due to excessive rainfall	1.18

Benchmark =3.00

Utilization of adaptation strategies

Table 3 shows that cocoa farmers utilized multiple adaptation strategies to reduce the effects of climate on cocoa farm because no single strategies that can cushion devastating impacts of climate change on cocoa. The findings show that agroforestry or planting of shade plants/trees (mean = 2.77) was ranked first among the strategies utilized by cocoa farmers. This implies that planting shade plants or trees especially plantain was considered as the best adaptation strategy utilized to mitigate effects climate change because it serves as a protective cover for cocoa seedlings and new cocoa tree from the high intensity of direct sunlight during drought; serve as wind break and source of food and support family income to the farmer until cocoa trees begin to fruits (Osei, 2017). Frequent spraying of cocoa farm with agrochemicals especially fungicides to prevent spread of black pod disease during the months of excessive rainfall, high humidity with little or no sunshine (mean = 2.72) ranked 2nd. This not surprising because the farmers acknowledged that frequent spraying of fungicides prevent poor yield and high post-harvest losses. This agrees with the submission of Obaniyi et al. (2019), Ehiakpor et al. (2016), Jiri et al., (2015) and Osei (2017) which established that cocoa farmers adopted agrochemicals such as pesticides to reduce the impact of climate change. Planting of improved varieties of cocoa seedlings (mean = 2.70) ranked next, because of the short period of maturity of improved cocoa seeds which is between three to four years and its high yielding capacity which made cocoa farmers considered it as a vital adaptation strategy to mitigate climate change and boost production. This is in tandem with the finding of Ehiakpor et al. (2016) and Osei (2017). Mixed cropping with other crops (mean = 2.69) ranked 4th, this may be connected to the fact that when cocoa are intercropped with any of the following economic crops plantain, banana, cocoyam and cassava at early stage of cocoa, it will provide shade to the young cocoa trees and improve moisture content of the soil; also, these crops also have short gestation period and which can be cushion the effects change through steady supply of foods. This is line with the reports of Osei (2017) and Addaney et al. (2021) who found out that larger percentage of the smallholder farmers adopted in mixed cropping activities to reduce the vulnerability and overcome livelihood challenges of climate change. Praying for the rain (mean=2.68) next to mixed cropping, this is not surprising because cocoa farmers believed that God was responsible for change in weather and only God that can give good weather and good yield. This confirms the submission of Obaniyi et al. (2019) who revealed that cocoa farmers in Southwestern Nigeria depended on prayers for rainfall and good weather. Changing time of planting of new seeds and seedlings, weeding and harvesting (mean=2.48) ranked 6th. This is to ensure full establishment of seedlings on the field before onset of dry season to prevent dying off of cocoa seedlings. The use of fire tracing or fire belt (mean = 2.30) ranked 7th, this practice is done by clearing bush surrounding the cocoa farm at least 10 meters away from the cocoa farm to prevent fire outbreak in cocoa farm of harsh weather conditions especially during harmattan period. This substantiates the findings of Osei (2017) who reported that cocoa farmers in Ghana created fire belt around their cocoa farms to curb bushfire. Use of fertilizer (mean=2.23), planting of drought resistant varieties (mean=1.83) and use of organic manure (mean = 1.54) ranked 8th, 9th and 10th respectively. Based on the benchmark of 1.5, the above adaptation strategies were major strategies utilized by cocoa farmers. Others strategies such as crop diversification (mean=1.38), use of pest and disease resistant varieties (mean = 0.31), switching to non-farm activities (mean = 0.17) and switch to livestock farming (mean = 0.09) were the minor adaptations strategies utilised. It could be inferred from this study that the cocoa farmers are using different proactive strategies to cushion devastating climate change impacts on cocoa so as to enhance optimum and sustainable cocoa production. This agrees with the reports of Kosoe & Ahmed (2022) and Okeniyi et al. (2021) that cocoa farmers employed different key adaptation strategies to cushion the impact of climate change.

Table 3. Adaptation strategies utilized by cocoa farmers

Tablo 3. Kakao üreticileri tarafından kullanılan adaptasyon stratejileri

Variables	Ranked mean
Agroforestry (planting of shade tree)	2.77
Frequent spraying of cocoa farm with pesticides	2.72
Planting of improved varieties	2.70
Mixed cropping with other crops	2.68
Praying for the rain	2.48
Changing the time of planting, weeding and harvesting	2.36
Fire tracing/belt around cocoa farm	2.30
Use of Fertilizer	2.23
Planting of drought resistant varieties	1.83
Use of organic manure	1.54
Crop diversification	1.36
Use of pest and disease resistant varieties	0.31
Diversification to non-farming activities	0.17
Switch to livestock farming	0.09

Benchmark=1.5

Level of utilization of adaptation strategies

Evidence in Figure 1 shows that 85.8 percent of cocoa farmers utilised adaptation strategies at high level to cushion climate change impacts on cocoa while few (14.2%) of respondents utilised adaptation strategies at low level to reduce climate change impacts on cocoa. The high level of utilisation by cocoa farmers was not unconnected to high awareness of cocoa farmers to perceived deleterious effects of climate change on cocoa production which force them to take some proactive measures to mitigate its effects since awareness is precursor to the adoption of any practice. This is similar to the reports of Okeniyi et al. (2013) and Agbongiarhuoyi et al. (2013) who reported high level of utilization of different adaptation strategies by cocoa farmers to reduce the negative influence of climate change on cocoa. However, the findings contradicts the findings of Obaniyi et al. (2019) who reported low usage despite high level of awareness of its negative impacts on cocoa.

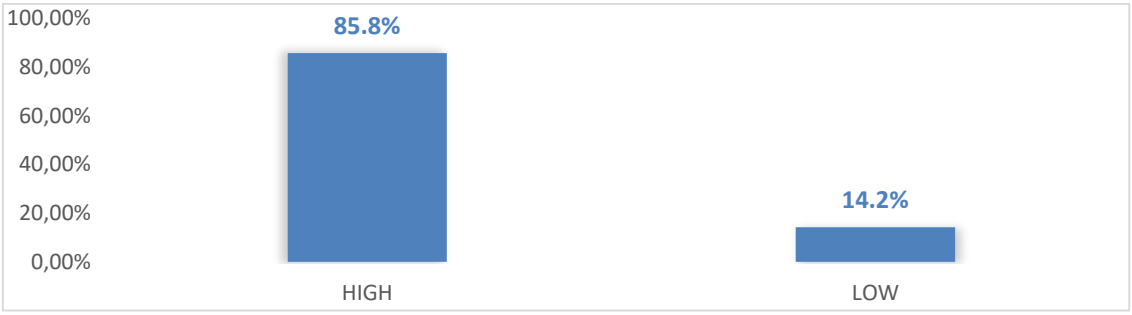

Figure 1. Level of utilisation of adaptation strategies

Şekil 1. Uyum stratejilerinden yararlanma düzeyi

Barriers to the usage of adaptation strategies

Evidence presented in Table 4 show that high cost of inputs like fertilizers (mean = 2.83) was considered as the most serious barrier to the utilization of adaptation strategies as it hinders cocoa farmers from using farm inputs to reduce the effects of climate change (Acquah, 2011). This agrees with the report of Osei (2017) who submitted that expensive inputs as the most serious constraint to adaptation strategies. Unpredictable weather (mean = 2.79) ranked 2nd, which was serious barrier because it makes it difficult for farmers to strategies in advance or practise

suitable adaptation strategies to reduce the impacts of climatic change (Fagariba et al., 2018). Inadequate weather information (mean = 2.77) ranked next because accessing weather information is an important tool to strategies ahead against any unforeseen consequence on their farms so as to reduce shock effects. Others include inadequate access to credit facilities or loans (mean = 2.73), inadequate access to irrigation facilities (mean = 2.72), inadequate extension agents (mean = 2.68), inadequate labour (mean = 2.61) and lack of government supports to the farmers (mean = 2.61). Based on the benchmark of 1.5, the results reveal that cocoa farmers indicated that all the constraints constituted major barriers to the utilization of adaptation strategies to climate change. This gives credence to the submission of Obaniyi et al. (2019), Fagariba et al. (2018), Osei (2017) and Ndamani & Watanabe (2015) who reported that high cost of farm input, unpredictability of weather, lack of access to credit facilities, inadequate extension workers and poor weather information were some of the barriers limiting the adoption of adaptation strategies to cushion the impacts of climate change.

Table 4. Barriers to use of adaptation strategies

Tablo 4. Uyum stratejilerinin kullanılmasının önündeki engeller

Variables	Ranked mean
High cost of inputs	2.83
Unpredictable weather	2.79
Inadequate weather information	2.79
Inadequate access to credit facilities	2.72
Inadequate access to irrigation facilities	2.70
Inadequate extension agents	2.68
Inadequate farm labour	2.61
Inadequate government support for farmers	2.60

Results of analysis between socio-demographic features and adaptation strategies

Results in Table 5 show that sources of information on awareness of climate change (χ^2= 25.887) and main occupation of the respondents (χ^2= 8.580) were significantly associated with the level of utilization of the adaptation strategies at 0.05 level of significance. This means that sources of information and main occupation of farmers could determine the utilization of adaptation strategies. Also, age (r=-0.501) had negative and significant relationship with the utilization of adaptation strategies while years of engaging in cocoa production (r=0.551) were positively correlated with utilization of adaptation strategies to climate change as shown in Table 6. The inverse relationship between age and utilization of adaptation strategies suggests that cocoa farmers who are younger utilise adaptation strategies more than the older folks. This implies that young farmers are more innovative, willing and ready to utilise adaptation strategies. This corroborates the report of Dembele et al. (2019) who found that age of the farmers had inverse relationship with the practice of adaptation strategies among Malian farmers. Also, the higher the years of engagement in cocoa production, the higher the utilization of adaptation strategies by cocoa farmers and vice versa. This is similar to the findings to the Ogunjimi & Ikefusi (2021) who reported that years of experience and usage of adaptation strategies were positively correlated.

Table 5. Association between selected socio-demographic features and adaptation strategies utilized by cocoa farmers

Tablo 5. Seçilen sosyo-demografik özellikler ile kakao çiftçilerinin kullandığı adaptasyon stratejileri arasındaki ilişki

Socio-economic variables	χ^2	D. F	P
Sex	0.486	2	0.784
Marital status	8.172	6	0.226
Religious affliation	1.729	2	0.421
Ethnicity	7.061	4	0.133
Major occupation	8.580*	4	0.037
Educational level	4.050	8	0.53
Climate information sources	25.887*	12	0.011

Table 6. Correlation analysis between selected socio-demographic features and adaptation strategies utilized by cocoa farmers

Tablo 6. Seçilen sosyo-demografik özellikler ile kakao çiftçilerinin kullandığı adaptasyon stratejileri arasındaki korelasyon analizi

Variables	Correlation coefficient (r)	P-value
Age	-0.501*	0.040
Family size	0.001	0.994
Years of residence	0.112	0.225
Years of engagement in cocoa production	0.551**	0.010
Farm size	-0.083	0.366

Correlation analysis between impacts of climate change and adaptation strategies

Evidence in Table 7 shows that the impact of climate change on cocoa (r= 0.421; $p \geq 0.05$) and utilization of the adaptation strategies by cocoa farmers were not significantly related. This implies that how the farmers perceived the climate change impacts on the cocoa production does not affect their utilization of adaptation strategies. This is contrary to the submission of Ehiakpor et al. (2016) and Jiri et al. (2015) which affirmed that perception on climate change was positively related to the practice of adaptation strategies among the cocoa farmers.

Table 7. Correlation analysis between the adaptation strategies utilized and perceived impacts

Tablo 7. Kullanılan uyum stratejileri ile algılanan etkiler arasındaki korelasyon analizi

Variables	Correlation coefficient (r)	P-value
Perceived impacts of climate change	0.421	0.712

In conclusion, all the respondents were aware and also experienced the negative impacts of climate change on cocoa. Majority of the farmers heard about on climate change from their co-farmers and friends. The study showed that effects of climate change on cocoa were retarded growth of cocoa seedlings, low yield of cocoa and increase in susceptibility of cocoa to diseases. Key adaptation strategies utilised to mitigate the effects of climate change on cocoa were planting of shade trees, frequent spraying of cocoa farms with pesticides and practice of mixed cropping. High cost of fertilizer, unpredictable weather and inadequate technical know-how were the prime barriers to the utilization of adaptation strategies to reduce climate change impact on cocoa. The study revealed that cocoa farmers used multiple strategies to cushion climate change impacts on cocoa. It is recommended that government need to develop sustainable cocoa programme in order to address to possible problems of climate change because most of the strategies presently adopted by farmers need improvement to ensure appropriate agronomic and adaptation strategies. Government should employed more extension agents to provide training and technical information to the farmers on how to reduce the climate change impacts on cocoa. Cocoa research institutes of

Nigeria (CRIN)should develop and promote different drought-tolerant, high yielding, pest and disease resistant varieties of cocoa that would adapt to climate variability. Extension services in collaboration with CRIN should collect, process and spread timely weather information on sound adaptation strategies that would boost cocoa production. Relevant government agencies and research institutes need to develop irrigation facilities to enhance water availability especially during drought. Metrological stations should provide timely weather information to the farmers so as to effectively plan and implement strategies. Finally, government and Non government organisations should provide for adequate loans to farmers to meet their financial demands on the use of adaptation strategies for sustainable cocoa production in Nigeria.

STATEMENT OF CONFLICT OF INTEREST

The author(s) declare no conflict of interest for this study.

AUTHOR'S CONTRIBUTIONS

Famakinwa contributed 50%, Adeloye contributed 30% while Oni contributed 20% to this research.

STATEMENT OF ETHICS CONSENT

Ethical approval is not applicable, because this article does not contain any studies with human or animal subjects.

REFERENCES

Acquah, H.D. (2011). Farmers´ perception and adaptation to climate change: A willingness to pay analysis. *Journal of Sustainable Development in Africa, 13,* 150-161 http://dx.doi.org/10.22004/ag.econ.120241

Addaney, M., Sarpong, G.E., & Akudugu, J.A. (2021). Climate change adaptation in Akropong, Ghana: Experiences of female smallholder farmers. *Journal of Land and Rural Studies, 9* (2), 344-367. https://doi.org/10.1177/23210249211008537

Adeyemo, R.A., Oladoja, M.A., Famakinwa, M., & Alabi, D.L. (2017). Assessment of utilisation of soil management practices among arable crop farmers in Ogun State: Implication for sustainable agriculture in Nigeria. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 17* (3), 37-45.

Adisa, B.O., Famakinwa, M., Adeloye, K.A., & Adigun, A.O. (2022). Crop farmers' coping strategies for mitigating conflicts with cattle herders: Evidence from Osun State, Nigeria. *Agricultura Tropica Et Subtropica, 55* OV, 191-201. https://doi.org/10.2478/ats-2022-0020

Afolayan, O.S. (2020). Cocoa production pattern in Nigeria: The missing link in regional agro-economic development. *Analele Universităţii din Oradea, Seria Geografie, 30* (1), 88-96. https://doi.org/10.30892/auog.301110-815

Agbeniyi, S.O., Adeniyi, D.O., & Ba, O. (2017). Impact of climate change on timing and frequency of fungicide application for the control of phytophthora pod rot of cacao in Nigeria. *International Symposium on Cocoa Research (ISCR),* Lima, Peru, November 2017.

Agbongiarhuoyi, A.E., Abdulkarim, I.F., Fawole O.P., Obatolu, B.O., Famuyiwa, B.S., & Oloyede, A.A. (2013). Analysis of farmers' adaptation strategies to climate change in cocoa production in Kwara State. *Journal Agricultural Extension, 17* (1), 10-22 http://dx.doi.org/10.22004/ag.econ.287164

Agro news Nigeria (2017). Cocoa Production in Nigeria. Retrieved from http://www.agronewsng.com/cocoa-production-nigeria-investment-data-statistics/

Alabi, D.L., Alao, O.T., Famakinwa, M., & Ogunleke, T.R. (2020). Gender assessment of coping strategies adopted by rural households during economic recession: A case of Osun State, Nigeria. *Contemporary Agriculture,69* (3-4), 81-89.

Alemu, M., & Desta, Y. (2021). Determinants' of farmers' perception of climate variability and change and its effect on non-farm income diversification. *Journal of Economics and Sustainable Development, 12* (11), 45-59.

Bayel, J.D., & Salau, E.S. (2018). Crop farmer's adaptive strategies for mitigating climate change effects in Sango Kataf Local Government Area, Kaduna, Nigeria, enhancing capabilities of farmers and farm communities through agricultural extension. *Proceeding of the 23rd Annual National Conference of the Agricultural Society of Nigeria,* 119-128.

Cilas, C., & Bastide, P. (2020). Challenges to cocoa production in the face of climate change and the spread of pests and diseases. *Agronomy, 10* (9), 1232. https://doi.org/10.3390/agronomy10091232

Clements, R., Haggar, J., Quezada, A., & Torres, J. (2011). Technologies for Climate Change Adaptation – Agriculture Sector. X. Zhu (Ed.). UNEP Risø Centre, Roskilde, 218 p.

Dembele, Y.M., Akinbile, L.A., & Aminu, O.O. (2019). Adaptation strategies to climate change among cereal crop farmers in Kita, Kayes Region of Mali. *Journal Agricultural Extension, 23* (3), 107-116. http://doi.org/10.4314/jae.v23i3.9

Ehiakpor, D.S., Danso-Abbeam, G., & Baah, J.E. (2016). Cocoa farmer's perception on climate variability and its effects on adaptation strategies in the Suaman District of Western Region, Ghana. *Cogent Food and Agriculture, 2* (1), 1-12. https://doi.org/10.1080/23311932.2016.1210557

Elisha, K.D., Elvis, D.O., Derick, T.A., & Ohene, A.B. (2017). What are the drivers of cocoa farmers' choice of climate change adaptation strategies in Ghana? *Cogent Food and Agriculture, 3,* 1334296. https://doi.org/10.1080/23311932.2017.1334296

Fagariba, C.J., Song, S., & Soule-Baoro, S.K.G. (2018). Climate change adaptation strategies and constraints in Northern Ghana: Evidence of farmers in Sissala West District. *Sustainability, 10,* 1-18. http://doi.org/10.3390/su10051484

Falola, A., & Fakayode, S.B. (2014). Awareness and effects of climate change on cocoa production in Ondo State, Nigeria. *International Journal of Applied Agricultural and Agricultural Research, 10* (1&2), 91-97.

Famakinwa, M., Agboola, A.F., & Alabi, D.L. (2017). Assessment of communal influence on land accessibility among rural land-users in Osun State, Nigeria. *FUW Trends in science and Technology Journal, 2* (1),423-427.

FAOSTAT (2022). Food and Agriculture Organization Statistics, Rome, Italy. Available online at http://www.fao.org/faostat/en/#home

Gateau-Rey, L., Tanner, E.V.J., Rapidel, B., Marelli, J.P., & Royaert., S. (2018). Climate change could threaten cocoa production: Effects of 2015-16 El Niño-related drought on cocoa agroforests in Bahia, Brazil. *PLoS ONE, 13* (7), e0200454. https://doi.org/10.1371/journal.pone.0200454

Gbigbi, T.M., & Ndubuokwu, G.O. (2022). Determinants of agricultural insurance patronage among crop farmers in Delta North Agricultural Zone, Delta State, Nigeria. *Ege Üniversitesi Ziraat Fakültesi Dergisi, 59* (2), 235-248. https://doi.org/10.20289/zfdergi.883004

Jiri, O., Mafongoya, P., & Chivenge, P. (2015). Smallholder farmer perceptions on climate change and variability: A predisposition for their subsequent adaptation strategies. *Journal of Earth Science and Climate Change, 6* (277), 1-7 https://doi.org/10.4172/2157-7617.1000277

Kosoe, E.A., & Ahmed, A. (2022). Climate change adaptation strategies of cocoa farmer in the Wassa East District: Implications for climate services in Ghana. *Climate Services, 26,* 100289. https://doi.org/10.1016/j.cliser.2022.100289

Ndamani, F., & Watanabe, T. (2015). Farmers' perceptions about adaptation practices to climate change and barriers to adaptation: A micro-level study in Ghana. *Water (Switzerland), 7* (9), 4593-4604. https://doi.org/10.3390/w7094593

Nigerian Informer (2023). Top 5 largest cocoa producing states in Nigeria. https://nigerianinformer.com/top-largest-cocoa-producing-states-in-nigeria/

Notre Dame Global Adaptation Initiative (ND-GAIN) (2021). ND-GAIN Country Index. https://gain.nd.edu/our-work/country-index/

Obaniyi, K.S., Kolawole, E.A., Ajala, A.O., & Owolabi, A.O. (2019). Indigenous and modern adaptation strategies to climate change among cocoa farmers in Southwest Nigeria. *Proceedings of the 24th Annual Conference of the Agricultural Extension Society of Nigeria,* Abuja 7-10 April 2019.

Ogunjimi, S., & Ikefusi, N. (2021). Strategies adopted by yam farmers in combating climate change in Kogi State Nigeria. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 21* (3), 594-599.

Okeniyi, M.O., Okeniyi, T.S., & Mustopha, F.B. (2021). Effects of climate change on pests and diseases, its awareness and adaptation strategies among Cocoa farmers in Abia State. *World Journal of Advanced Research and Reviews, 10* (03), 61-68. https://doi.org/10.30574/wjarr.2021.10.3.0227 .

Osei, E.M. (2017). Climate variability and cocoa production: The implications of micro-adaptation measures on cocoa farmers' income. Published M.Phil. Thesis University of Ghana. Legon. Available online at http://ugspace.ug.edu.gh

Oyekale, A.S., & Oladele, O.I. (2012). Determinants of climate change adaptation among cocoa farmers in Southwest Nigeria. *ARPN Journal of Science and Technology*, 2, 154-168.

Oyekale, A.S. (2015). Climate change induced occupational stress and reported morbidity among cocoa farmers in South-Western Nigeria. *Annals of Agricultural and Environmental Medicine, 22* (2), 357-361. https://doi.org/10.5604/12321966.1152095

Oyekale, A.S. (2019). Dataset on cocoa farmers' agrochemical handling practices and safety compliance in Ahafo Ano North District, Ashanti region, Ghana. *Data in Brief, 27,* 104767. http://doi.org/10.1016/j.dib.2019.104767

Oyekale, A.S. (2020). Dataset on cocoa production and climate change adaptation strategies in Ahafo Ano North District, Ghana. *Data in Brief, 29,* 1055275. http://doi.org/10.1016/j.dib.2020.105275

Rainforest Alliance (2017). Preparing Cocoa Farmers for Climate Change. Retrieved from https://www.rainforest-alliance.org/article/preparing-cocoa-farmers-for-climate-change

Shahbandeh, M. (2023). Cocoa bean production worldwide 2020/2021-2022/2023, by country. Statista. https://www.statista.com/statistics/263855/cocoa-bean-production-worldwide-by-region/