Evaluating Climate Smart Adaptation Practices on Cocoa Insect Pests and Diseases Incidences among Farmers in Cross River State, Nigeria

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Abstract:
Climate change impact during dry season and prolong rainfall poses great risk to cocoa and farmers' livelihood. This scenario creates ideal conditions for the spread of diseases in cocoa plantations. The study accessed Climate Smart Adaptation (CSA) practices used by farmers to mitigate insect pests and diseases challenges of cocoa in Cross River State. A systematic random sampling was used to select farmers across Boki, Etung and Ikom Local Government Areas to obtain a total of 132. Field data were collected with interview schedule and analysed with descriptive statistics and Pearson Product Moment Correlation. The results showed that majority of the farmers were a little above 45 years and had more of secondary education. Prolong rainfall and rainfall (50.7%) were ranked by the respondents as the main observed weather variables promoting the occurrence of insect pests and diseases in cocoa production. Removal of diseased and dried up cocoa pods from the tree regularly (66.7%), fungicides and insecticides application to cocoa trees during raining season (60.6%) and pruning (59.1%) proved to be effective (CSA) strategies used by farmers. Significant relationship existed between constraints farmers encountered and their (CSA) practices in coping with insect pests and diseases problems of cocoa ($r=0.172$, $p=0.050$ at $p \leq 0.05$). The study concludes that irrespective of limiting constraints, farmers were able to adapt to the effects of changing climate associated with insect pests and diseases situation in cocoa farms. It is recommended that farmers should ensure the use of approved pesticides to enhance adaptation.

Keywords: Climate smart agriculture, adaptation, cocoa insect pests and diseases

1. Introduction

Climate Smart Agriculture (CSA) is an approach that guides actions needed to transform and orient agricultural systems to effectively support development and ensure food security in a changing climate [1]. CSA includes practices and technologies that sustainably increase productivity and incomes, support farmers' adaptation to climate change, ensure food security and reduce levels of greenhouse gases. CSA provides the means to help stakeholders at local, national or international levels choose the agricultural strategies that are the most readily adaptable to specific climate conditions.

Cocoa production in Nigeria is rain-fed and is very sensitive to changing weather conditions. CSA aims to mitigate the negative impact of climate change on cocoa production and to adapt farmers' agricultural practices where necessary. Climate change is causing global shifts in temperature, precipitation patterns and CO_2 and non-CO_2 greenhouse gases. It brings about unpredictable and extreme weather events such as torrential rainfall, drought, bush burning, deforestation and sea level rise. This scenario is impacting significantly on global crop yields and food security [2,3]. Climate change is a risk multiplier of insect pests and diseases activities that affects cocoa production. In a world that is 2°C warmer than pre-industrial times, at least 189 million more people are at risk of becoming food insecure.

Climate change is directly and indirectly influencing the distribution and severity of crop pests, including invasive species, which is further affecting crop production [4,5]. Innovations in CSA help farmers to reach their production goals and build resilience. [6] reported that a global pattern of increasing latitudinal and altitudinal range of crop pests is anticipated, either through direct effects of climate change on the pests themselves or on the availability of host crops. Up to 40% of the world's food supply is already being lost to pests [7].

Cocoa farmers are exposed to extreme climatic events which are expected to increase as climate change continue to affect crops, animals and man. Cocoa contributes significantly to farm income of producers, government foreign exchange and rural employment, climate smart adaptation has become necessary to ensure sustainability. The sensitivity of cocoa production to hours of sunshine, rainfall, soil conditions and temperature makes it vulnerable to climate change. Changing climate can also alter development of pests and diseases and change the host's resistance. Unfavorable climate promotes insect pest infestation and disease outbreak on cocoa farms. Newly planted cocoa plants and some cocoa trees shrivel because of drought [8]. Extension services are therefore needed to support farmers with the reorientation of pest management practices under climate change for effective performance. It is against this backdrop that the study seeks to access the climate smart adaptation practices used by farmers to mitigate insect pest and disease challenges of cocoa in Cross River State. The specific objectives are to:
i. Describe the socio-economic characteristics of cocoa farmers.
ii. Identify the observed weather variables affecting insect pests and diseases in cocoa farming.
iii. Examine the strategies used by cocoa farmers in adapting to climate change.
iv. Ascertain the constraints farmers encounter in adapting climate smart practices of cocoa insect pest and diseases problems.

2. Materials and methods

2.1. Study area:
Nigeria has a tropical climate with two different seasons known as wet and dry seasons. They have varying lengths of rainy and dry seasons depending on the geographical location. In the South-South zone where the study was carried out, there is a longer period of rainy season commencing in March to November than the Northern zone (May to September). Cross River State is located on coordinates: $5^{o}45'$N $8^{o}30'$E. It is a coastal state located in the Niger Delta region, and occupies 20,156 square kilometers. It shares boundaries with Benue State to the north, Ebonyi and Abia States to the west, to the east by Sud-Ouest Province in Cameroon, and to the south by Akwa-Ibom and the Atlantic Ocean [9].

2.2. Pre-data collection: Farmers were showed samples and pictures of cocoa insect pests and diseases before data were collected from then. This exercise was done in order to guide the farmers on proper identification of pests and diseases that affects cocoa. These include mirids/capsids, stem borer, mealybugs, pod husk borer, leaf defoliators, termites, tailor ants shield bugs and Psyllids. The diseases were black pod, thread blight (leaf disease), cherelle wilt, brown pod rot and cocoa swollen shoot virus. Some of these pictures are displayed in Figures 1-4.


1. Black pod disease


2. Cocoa mirid


3. Cocoa shield bug

4. Cocoa stem borer

2.3. Data collection and processing:

A multistage sampling procedure was used to select the sample for the study. Cross River State was purposively selected for the study due the predominance of cocoa production and the coastal nature of producing communities in the Southern State. At the first stage, we randomly selected three major cocoa growing Local Government Areas (LGAs): Boki, Etung and Ikom. The second stage involves random selection of two villages from each LGA. At the third stage, a list of registered farmers from the Cocoa Association of Nigeria was used to sample 55 farmers from Boki, 42 from Etung and 35 from Ikom making a total of 132 based on level of production. Structured interview schedule was used to collect field data. Descriptive (mean, frequency, percentage distribution) and inferential statistics were used for data analysis. Data were analysed with Statistical Package for Social Sciences (SPSS) software to obtain the Pearson Product Moment Correlation PPMC (r). The r and p-values at ($P< 0.05$) were used to understand which variables were significant and not significant in the study.

The instrument used for data collection contains independent variables (Personal characteristics): sex, age, educational level, farm size and age of cocoa farm. Other variables investigated include observed weather variables and constraints encounter by farmers in adapting climate smart practices of insect pest and diseases incidences. The dependent variable was climate smart practices adopted by cocoa farmers. Descriptive statistics (mean, frequency, percentage distribution) were used to analyse the independent variables. PPMC was used to determine the significant variable. The CSA practices were measured on a three-point scale as not effective which was scored 0, effective scored 1 and very effective scored 2. The highest possible score was 30 and the lowest score was 0. The weighted average score of each item was used to rank items according to the order of effectiveness. Secondary data were also obtained from published and unpublished sources found in journals, books, proceedings and other materials.

Measurement of independent variables of the study.

Variables	**Description**	**Variable type/criteria**
Sex	Sex of farmers	Dummy: Male =1, Female=2
Age	Age of farmers	Continuous variable
Educational level	Status of education of farmers	Categorical variable: No formal education=0, Primary=1, Secondary=3, Tertiary=4
Cocoa farm size	Total cocoa farm size in Ha	Continuous variable
Farm age	Age of cocoa farm in years	Continuous variable
Observed weather variables	Climate change variables observed by farmers	Prolong rainfall =1, Rainfall=2, Humidity =3, Prolong dry season=4, Temperature changes=5, Drought=6
Constraints	Farmers' constraints with score value	Categorical variable: Not serious =0, Serious =1, Very serious =2

3. Results

3.1. Socio-economic characteristics of farmers

The variables in table 1 shows that 81.1% of the farmers were males. The mean age of farmers was about 46 years. The respondents have one form of formal education with more of them having secondary education, 47% while 23.5% had the basic primary education. The average farm size of farmers was 12.8 hectares. The mean age of most of the cocoa farms was a little above 18 years suggesting that the cocoa trees are still useful in terms of production. The aforementioned variables have ways of influencing insect pests and diseases control of cocoa.

Table 1: Socio-economic characteristics of farmers N=132

Variables	Frequency	Percentage	Mean
Sex			
Male	107	81.1	
Female	25	18.9	
Age of respondents (Years)			45.05
≤ 25	12	9.1	
26-35	18	13.6	
36-45	42	31.8	
46-55	30	22.7	
56-65	21	15.9	
66 and above	9	6.8	
Educational Level			
No formal education	10	7.6	
Primary	31	23.5	
Secondary	62	47.0	
Tertiary	29	22.0	
Cocoa farm size (Hectare)			12.79
1-5	81	61.3	
6-10	31	23.5	
11-15	8	6.1	
16-20	7	5.3	
21 and above	5	3.8	
Age of cocoa farm (Years)			18.36
1-5	14	10.6	
6-10	31	23.5	
11-15	28	21.2	
16-20	30	22.7	
21-25	9	6.8	
26 and above	20	15.2	

Source: Field survey, 2020

3.2. Observed weather variables promoting insect pests and diseases incidences in cocoa production.

Prolong rainfall (34.8%), rainfall (15.9%) and humidity (15.2%) were ranked by the respondents as first, second and third respectively as the main observed weather variables promoting the incidence of insect pests and diseases in cocoa production (Table 2). The least variable happens to be drought which was rated 6th position.

Table 2: Ranked observed weather variables affecting insect pest and diseases in cocoa production N=132

Observed weather variables	Frequency	Percentage	Rank
a. Prolong rainfall	46	34.8	1st
b. Rainfall	21	15.9	2nd
c. Humidity	20	15.2	3rd
d. Prolong dry season	17	12.9	4th
e. Temperature changes	16	12.1	5th
f. Drought	12	9.1	6th

Source: Field survey, 2020

3.3. Climate Smart Adaptation (CSA) practices of farmers towards cocoa insect pests and diseases incidences

The effectiveness of climate smart adaptation strategies practiced by farmers in managing the occurrence of insect pest and diseases of cocoa amidst climate change is explained in table 3. Removal of diseased and dried up cocoa pods from the tree regularly (66.7%), Fungicides and insecticides application to cocoa trees in raining season (60.6%), pruning of cocoa trees (59.1%), pesticide application to cocoa trees before commencement of rains (55.3%), weeding by hand slashing (54.5%) and use of improved cocoa varieties (51.5%) respectively were the most effective climate smart adaptation strategies used by farmers in coping with the challenges of insect pests and diseases in cocoa plantations. However, the use of agro-meteorological and climatological services (29.5%) from the Nigeria Meteorological Agency (NIMET) shows the least adaptation option used by farmers. Also, 45.5% of the farmers claimed that using NIMET strategy was not effective.

Table 3: Climate Smart Adaptation practices of farmers towards cocoa insect pest and diseases incidence N=132

Climate Smart Adaptation Practices of farmers	Not effective	Effective	Very effective
1. Fungicides and insecticides application to cocoa trees before commencement of rains	25(19.0)	34(25.8)	73(55.3)
2. Fungicides and insecticides application to cocoa trees in raining season	18(13.6)	3(25.8)	80(60.6)
3. Use of improved cocoa varieties	15(11.4)	49(37.1)	68(51.5)
4. Removal of diseased and dried up cocoa pods from the tree regularly	10(7.6)	34(25.8)	88(66.7)
5. Physical removal of insect pests from cocoa farm	28(21.2)	47(35.6)	57(43.2)
6. Pruning of cocoa trees	12(9.1)	42(31.8)	78(59.1)
7. Weeding by hand slashing	17(12.9)	43(32.6)	72(54.5)
8. Weeding by herbicides application	53(40.2)	48(36.4)	31(23.5)
9. Use of agro-meteorological and climatological services from NIMET	60(45.5)	33(25.0)	39(29.5)
10. Integrated Pest Management (IPM)	39(29.5)	40(30.3)	53(40.2)

Source: Field survey, 2020 Figures in parentheses are percentages

3.4. Constraints encounter by farmers in adapting climate smart practices of insect pest and diseases

The result in Table 4 shows that high cost of pesticides (88.7%), financial problem (83.3%) and labour cost (75%) constituted very serious constraints to climate smart practices in terms of insect pest and diseases control of cocoa. What this means is that the constraints did not prevent the farmers from tackling the problem of insect pest and diseases. It shows the resilient nature of cocoa farmers in adapting to climate change.

Table 4: Ranked constraints encountered by farmers in adapting climate smart practices of cocoa insect pests and diseases N=132

Constraints	Not serious	Serious	Very serious	Rank
High cost of pesticides	2(1.5)	13(9.8)	117(88.7)	1st
Financial problem	3(2.3)	19(14.4)	110(83.3)	2nd
Labour cost	1(0.8)	32(24.2)	99(75.0)	3rd
Inadequate climate change information	21(15.9)	36(27.3)	75(56.8)	4th
Emerging or new pest problem	42(31.8)	34(25.8)	56(42.4)	5th

Source: Field survey, 2020 Figures in parentheses are percentages

3.5. Correlation between constraints encountered by farmers and climate smart adaptation practices to insect pest and diseases of cocoa.

There was a significant relationship between constraints farmers encountered and their climate smart adaptation practices in coping with insect pest and diseases problems of cocoa ($r=0.172$, $p=0.050$ at $p\leq0.05$) Table 5. The constraints identified in this study are important variables that needs to be taken into consideration in achieving sustainable CSA practices for enhanced insect pests and diseases control in cocoa plots.

Table 5: Correlation between constraints encountered by farmers and climate smart adaptation practices N=132

Variable	R	P	Decision
Constraints encounter by farmers in adapting climate smart strategies	0.172	0.05**	S

Source: Field survey, 2020 S=Significant

4. Discussion

4.1. Socio-economic characteristics of farmers

The socio-economic characteristics of farmers shows that there were more males than female farmers. This suggests that male respondents dominated cocoa production with respect to insect pest and diseases control. The mean age of farmers gives an indication that they were still within the active production age for cocoa farming activities. This result is similar to that of [10]. They reported that cocoa farmers were in their middle ages which implied they were still in their economic active age and would result in positive effect on production. The respondents' educational status was more of secondary and primary education. This will no doubt increase their knowledge in controlling the challenges of insect pest and diseases under a changing climate. A greater number of the farmers own large farm sizes which is mainly due to flexible land acquisition strategy of Cross River State government, more youths' involvement and community support in cocoa farming. Also, the State is the second largest cocoa producer in Nigeria. This result agrees with [11]. The mean age of most of the cocoa farms was less than 19 years which indicates that the farm is still relatively young and within the productive years for cocoa in the study area.

4.2. Observed weather variables

In table 2, Prolong rainfall, rainfall and humidity were ranked by the respondents as the main observed weather variables promoting the incidence of insect pests and diseases in cocoa production. It implies that the study area experienced a lot of precipitation which is due to the coastal nature of Cross River States of Nigeria. High precipitation is usually a common phenomenon in the study area, which is conducive for insect pests and diseases incidence, hence, predisposing cocoa to attack. In [12], he found out that too much rainfall was largely perceived by farmers in promoting the problem of insect pests and diseases like black pod. Drought was ranked as a very minor issue which means it was not considered an important environmental factor affecting cocoa production in the study area.

4.3. Climate smart adaptation strategies used by farmers

The most effective climate smart adaptation strategies used by farmers in coping with the challenges of insect pests and diseases in cocoa plantations were the removal of diseased and dried up cocoa pods from the tree regularly, fungicides and insecticides application to cocoa trees in raining season, pruning of cocoa trees, pesticide application to cocoa trees before commencement of rains, weeding by hand slashing and use of improved cocoa varieties respectively (Table 3). These variables promote good cocoa development and improved yield. This result is in line with [13] who reported that increased pesticide application was the principal strategy used by many farmers to handle climate-induced pest increases. Farmers need to spray their cocoa trees with fungicides before and during the raining season otherwise, they will end up getting nothing from cocoa because of high incidence of black pod diseases prevalence. It is very important for farmers to use approved pesticides to ensure quality and sustainable cocoa. Agro-meteorological and climatological services approach from the Nigeria Meteorological Agency (NIMET) was less used by farmers. The farmers claimed that this strategy was not effective. The implication of this is that farmers are not getting enough climate information from NIMET for their cocoa farming activities, or they have limited knowledge about the use and interpretation of agro climate information in the study area. This strategy calls for intervention from cocoa partners, extension workers and policy makers to sensitize farmers on the benefits of utilizing NIMET services to improve cocoa climate smart agriculture.

4.4. Constraints encountered by farmers

The high cost of pesticides, financial problem and labour cost constituted very serious constraints to climate smart practices in terms of insect pest and diseases control of cocoa (Table 4). What this means is that the constraints did not prevent the farmers from tackling the problem of insect pest and diseases. Despite the limiting constraints, farmers continue to adapt some climate smart practices in controlling insect pest and diseases. It shows the resilient nature of cocoa farmers in adapting to climate change. It goes to explain that farmers are taking cocoa farming as a serious business in order to sustain their livelihoods even in the daunting challenges of changing climate. This is true because cocoa farming is a major business in Cross River State. The negative implication of this result is that a situation whereby pesticides becomes expensive give room for farmers to buy cheap and unapproved ones that could introduce residue and reduced the quality of cocoa beans. The work of [14] agrees with the result of this study. They reported that the problem of insect pest and diseases could constraint cocoa production due to the use of pesticides.

5. Conclusions and Policy Recommendation

The study concludes that irrespective of limiting constraints encountered by cocoa farmers, they were able to adapt to the effects of changing climate associated with insect pests and diseases situation in cocoa farms. Fungicides and insecticides application to cocoa trees before and during raining season, pruning of cocoa tress, weeding by hand slashing and use of improved cocoa varieties respectively were the most effective climate smart adaptation strategies used by farmers in coping with the challenges of insect pests and diseases in cocoa plantations. It is recommended that farmers should sustain their current practices, ensure the use of approved pesticides and NIMET services to boost cocoa yields.

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