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Perception on the Causes and the Impacts of Climate Change on Ecosystem Services Provided by *Cola nitida* (Vent.) Schott & Endl in Nigeria

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ABSTRACT

Kolanut (*Cola nitida)* is a tropical multipurpose agroforestry tree species in Nigeria, the species receives little attention from studies geared towards assessing the impact of climate change on the services it provides. The study investigated farmers' views on the impacts of current changes in climatic variables on the ecosystem services the species provides in Nigeria. This study was conducted by interviewing farmers cultivating *C. nitida*, using the purposive sampling method and focus group discussion (FGD). Data were obtained by using structured questionnaires and interview sections. Data was analyzed using descriptive and inferential statistics. Results showed that about 96% of respondents revealed that climatic factors such as a change in rainfall pattern, drought, and temperature influenced the survival and fruiting patterns of *Cola nitida* in Nigeria. The regressions showed that age, gender, marital status, education level, and household size significantly influenced farmers' perception of climate change. The results revealed that climate change will have a significant influence on the ecosystem services (productivity, supporting, cultural and regulating) provided by this species. Rural farmers should be encouraged to domesticate this species in Nigeria as mitigating measure to climate change and maximize the ecosystem services provided by *Cola nitida* for improved livelihood.

Key words: Climate Change - *Cola nitida* - Ecosystem services – Farmers - Multipurpose trees.

INTRODUCTION

The socio-ecological approach to biodiversity conservation and management is gaining popularity (Bennett 2016). This entails the assessment of people's perceptions, values, attitudes, and beliefs on biodiversity conservation (Ban et. al. 2013, Martın-Lòpez *et al*. 2015). The importance of such assessment has widely been acknowledged because biodiversity is crucial to human livelihoods and wellbeing through the provision of ecosystem services, generally referred to as biodiversity benefits (D´ıaz *et al*. 2006, Cardinale *et al*. 2012, Martın-Lòpez *et al*. 2015, MA 2015). The need to engage change in societal attitudes towards biodiversity conservation, therefore, is becoming increasingly cogent (Martın-Lòpez *et al*. 2012).

The annual income and economy of a large number of countries in sub-Sahara Africa (SSA) are highly vulnerable because they depend mainly on weather-sensitive agricultural systems D´ıaz *et al*. (2006). The African region is known as one of the major areas of the world that are largely susceptible to climate change [(IPCC 2014, Graciela *et al*. 2014). Changes in climatic variables have been reported as a major threat to agricultural production and productivity (IPCC 2007; Deressa *et al.* 2008). Current and predicted climate change scenarios have identified emissions of greenhouse gases such as CO_2 and CH_4 as a threat to human socio-economic activities such as agriculture, forestry, livelihoods, biodiversity conservation, and ecosystem functions (IPCC 2007; Lepetz *et al.* 2009, Dejene *et al.* 2018). Indeed, the effects of global warming and climate change have been observed to negatively affect the growth, phenology, and reproduction of plants (Parmesan *et al.* 2015).

Cola nitida (Kola nut) is an important cash crop in Nigeria and major agricultural produce for trade in many West African countries and Trans-Saharan trade routes for many centuries (Oke *et al.* 2011). The species is used as a masticatory stimulant by Africans and has numerous uses in social, religious, ritual, and ceremonial functions by natives in the forest region of Africa (Ndagi *et al.* 2012).

Cola nitida is preferred commands significant interest in the international trade because of its high caffeine content and flavoring kola drinks (production of soft drinks and wines). Other provisioning ecosystem service provided by kola includes the manufacture of dyes, income generation, sources of food, used as a masticatory and stimulant, and industrial usage in pharmaceuticals. Cola has its cultural significance and command attention in social function and traditional ceremonies in Nigeria. Nigeria was reported to produce about 120,000 tons of Kolanut annually (Ajiboye and Afolayan 2009) which accounts for about 70% of the total world production of kola nuts (Oluokun and Oladokun,1999). Kolanut is the third most important crop among the world's stimulants whose global production covered about 47 million tons in 1985 (Micheal 1985). Ojo and Ehinmowo (2010) reported that the kola nut production enterprise in Nigeria is still very profitable, about 90% of the kola nut produced in Nigeria is consumed within the country (Ojo and Ehinmowo 2010). There is also an increasing demand for its usage in pharmaceutical industries and the production of soft drinks, wines, and candles. Recently, in Nigeria, the cultivation of kola trees is now very limited, with the few old stands currently available associated with very low yields. The low productivity could be attributed to bottlenecks driven largely by climate change (Agwu *et. al*. 2018). Despite its influence, there is a paucity of information on the perception and views of rural farmers on the possible impact of climate change on Kola productivity in Nigeria. The decline in the population of the *Cola nitida* has been reported (Ndagi *et al. 2012)*, which implied a reduction of ecosystem services provided by the species. The species has also received little attention on ascertaining how significant the ecosystem services it provides are impacted by climate change. This knowledge gap was filled through analyzing the objectives of this study which is to (1) determine the ecosystem services provided *by C. nitida* in Nigeria, (2) investigate the perceptions of farmers on the causes and impact of climate change on ecosystem services provided by *C. nitida* and (3) identify the variables influencing farmers' perception to climate change in Nigeria. This knowledge is vital in identifying conservation challenges and developing scientific solutions to inherent climate change-induced constraints to the conservation of the species and invariably, the continued provision of its ecosystem services.

METHODS

Study area

Two main vegetation zones in Nigeria (humid forest and derived savanna) were purposely selected for this study (Figure.1).

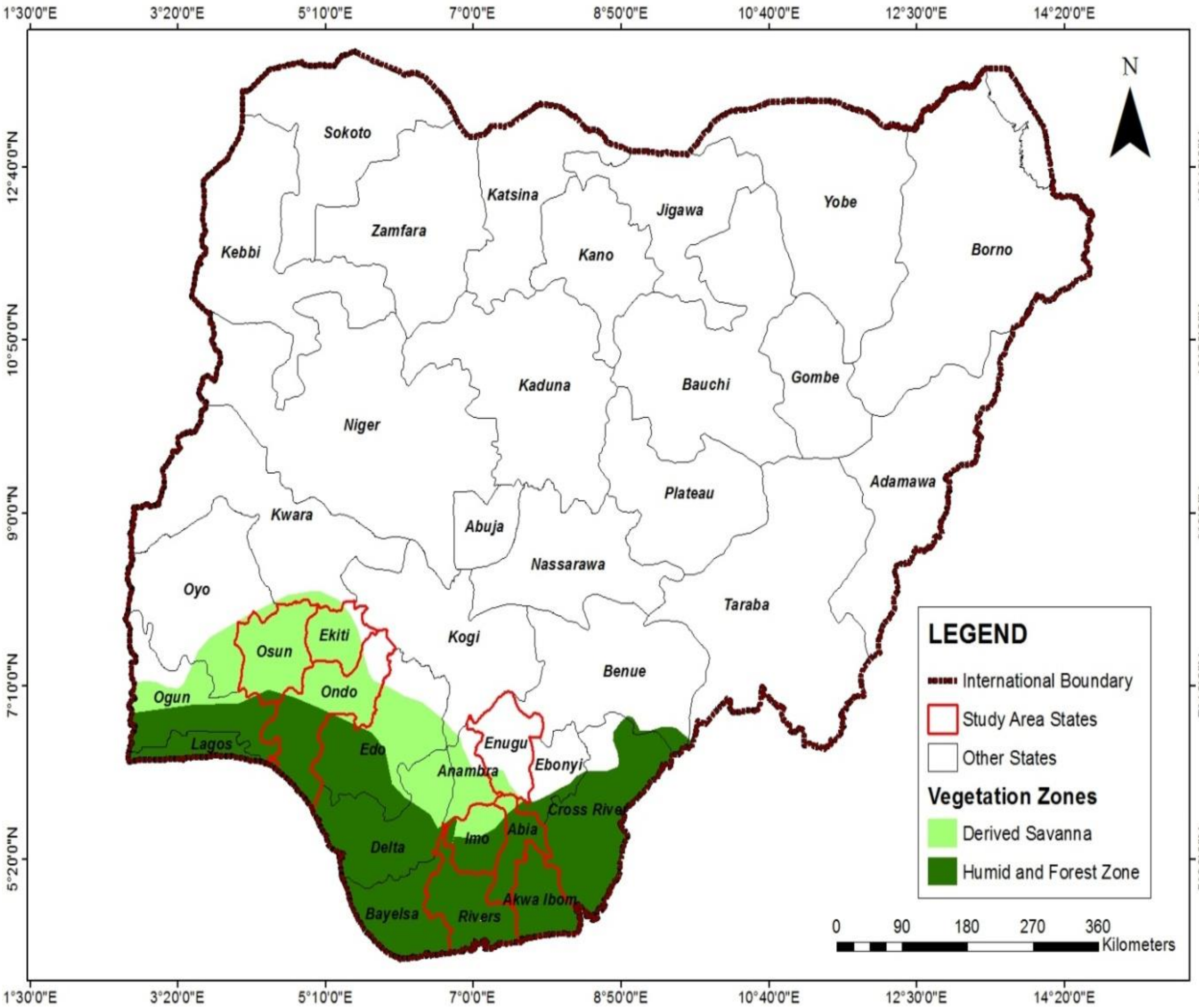

Figure 1. Map of the Study Area.

Humid or Rain Forest zone**:** This zone has a bimodal rainfall distribution characterized by a prolonged rainy season, with annual rainfall above 2,125 mm and annual temperature of about 27ºC. The humid zone accounts for a great number of plant species that are a major source of timber for the construction and furniture industry (FORMECU 1998). This zone is located within the 6º 33′ 19.64″N and 2º 25′ 16.46″E to 4º 39′ 40.25″N and 8º 34′ 40.25″E.

Derived Savanna zone: This zone is located immediately in the north of the tropical rainforestzone. It is the transition zone between the tropical rainforest and the guinea savannah zone. The average annual rainfall and temperature are 1458 mm and 26.6ºC, respectively. The zone covered with scattered trees and tall grasses (FORMECU, 1998) and the geographic location fall within 7º 10′ 24.54″N, 2º 49′ 13.57″E to 6 º21′00.92″N, 7º 10′ 06.35″E.

Determination of the sampling size and choice of climate parameters

The sample size was determined as was used by Agwu *et. al.* (2018). The first stage was a purposive selection of 60 kola farmers from the two vegetation zones and was used in a preliminary investigation to determine the proportion of respondents who have observed both changes in temperature and rainfall. Temperature and rainfall have been selected for the current study because their variation can easily be detected by the farmers.

Fifty percent of the respondents who have observed both changes in temperature and rainfall were used to calculate the sample size (N) described by Dagnelie (1998) formula:

$$N = \frac{u_{1}^{2} - {}^{\alpha}/_{2} P(1-p)}{d^{2}} \quad (1)$$

Where: N is the total number of households to be surveyed, i.e., the sample size; $u_1^2 - {}^{\alpha}/_2$ is the value of the normal random variable for a probability value of $\alpha = 0.05$; $U_{1-\alpha/2} = 1, 96$; *p* is the estimated proportion of people in the villages who have observed changes in both temperature and rainfall (*p* = 0.50); and *d* is the expected error margin of any parameter to be computed from the survey, which was fixed at 0.05. Then, from this formula the sample size (N) was estimated at 280 farmers for all the sites.

Data collection

A structured survey questionnaire and Focus Group Discussion (FGD) were used to collect information in the selected zones (Tardío *et. al*. 2005, Agwu *et. al*. 2018). Respondents were carefully selected in each vegetation zone based on age and empirical knowledge of *C. nitida*. A total of 280 kola farmers were interviewed to gather information on their understanding of the concept, causes, and drivers of climate change as well as the impacts of climate change on the fruits of *C. nitida. Also*, farmers were interviewed on their perception of the ecosystem services provided by *C. nitida*. One FGD was conducted in each selected zone to support and validate the information obtained from the questionnaires.

Sixteen FGD was held in 16 major farm villages, during the FGD, questions were asked in all the locations about the various ecosystem services provided by *C. nitida*, their knowledge, causes and drivers of climate change, how climate change has impacted on the ecosystem services provided by C. *nitida*.

Data analysis

Descriptive statistical analysis (frequencies and percentages) was performed using R programme software to document the farmers' demographic background and their perception of climate change. Chi-Square was used to ascertain the respondents' perception of the influence of climate change on benefits derived from *C. nitida*. The main determinant of farmers' perception and the influences of the respondent demographic background on climate change were investigated using a multinomial logit (MNL) regression. The MNL advantage of the multinomial logit is that it permits the analysis of decisions in more than two categories allowing the determination of choice probabilities for different categories of climate attributes. To describe the MNL model, let y denote a random variable taking on the values {1,2….J} for choices J, a positive integer, and let x denote a set of conditioning variables. For this study, y representing climate attributes such as temperature, floods, droughts, rainfall, and wind, it is also known as the independent variable study sites. The x the vector of farmers' characteristics (gender, age, education level, household size, marital status) also known as explanatory variable. MNL has been recognized to be more accurate and permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories of climate attributes (Tse 1987). This model is more appropriate and has been conventionally used (Sanogo *et. al*. 2017; Agwu et. al. 2018). The model is

P(y= j/x), j = 1,2, …, J.

Since the probabilities must sum to unity, p(y= j/x) is determined once we know the probabilities for j =2, …, J (Deressa *et. al*. 2009).

RESULTS

Demographic characteristics of Kola farmers

The gender distribution, matrimonial situation, occupation, literacy, and age dynamics of the respondents are given in Table 1. Of the 280 farmers interviewed, 52% of the respondent were from the study area, and 48% were from the derived savanna zone. About 37.9% of the respondents were within the age range of 31 and 40 years, 17.1% were between the age of 41 and 50 years, while only 11.8% of the respondents were between the age of 21 and 30 years old. The majority of the respondents were married (78.9%), 17.9% were single, while 3.2% refused to reveal their marital status (Table 1). Household sizes ranged from one (1) to seven (7); 36.1% of the respondents reported not having children. About 44.6% of the respondents had secondary school education, 23.9% had post-secondary school education while 14.3% were illiterate with no formal education. (Table 1). The majority of the participants were farmers (51.8%), 23.9% were traders and 10.4% were in public service. The respondents were aware of the concept of climate change and its associated effects (Figure 2). Sixty-five percent (65%) of the respondent revealed that there is a decrease in rainfall pattern, while 61, 54 and 57% of them reported an increase in temperature, drought, and flood, respectively (Figure 3).

Ecosystem services provision and influence of climatic factors in cultivating *Cola nitida*

During FGD, the farmers reported that the ecosystem services derived from *C. nitida,* ranges from provisioning services (food, raw materials, and energy), regulating services (microclimate regulation), cultural services (ritual, social and spiritual needs of people), and supporting in the study zones; this was revealed by most of the respondents (96.1%).

Table 1: Demographic and socioeconomic profile of farmers in the study zones

Respondents	Number	Percentage
Gender		
Male	221	78.9
Female	50	17.9
No response	9	3.2
Total	280	100
Age range		
21-30 years	33	11.8
31-40 years	106	37.9
41-50 years	48	17.1
51-60 years	40	14.3
≥ 60 years	44	15.7
No response	9	3.2
Total	280	100
Marital status		
Married	221	78.9
Single	50	17.9
No response	9	3.2
Total	280	100
Number of children		
≤2	19	6.8
02-04	79	28.2
05-07	81	28.9
No response	101	36.1
Total	280	100
Educational level		
No formal education	40	14.3
Post-secondary education	67	23.9
Primary education	30	10.7
Secondary education	125	44.6
Others	10	3.6
No response	8	2.9
Total	280	100
Occupation		
Farming/hunting	155	55.4
Trading	67	23.9
Civil servant/ Teacher	40	14.3
Others	18	6.4
Total	280	100

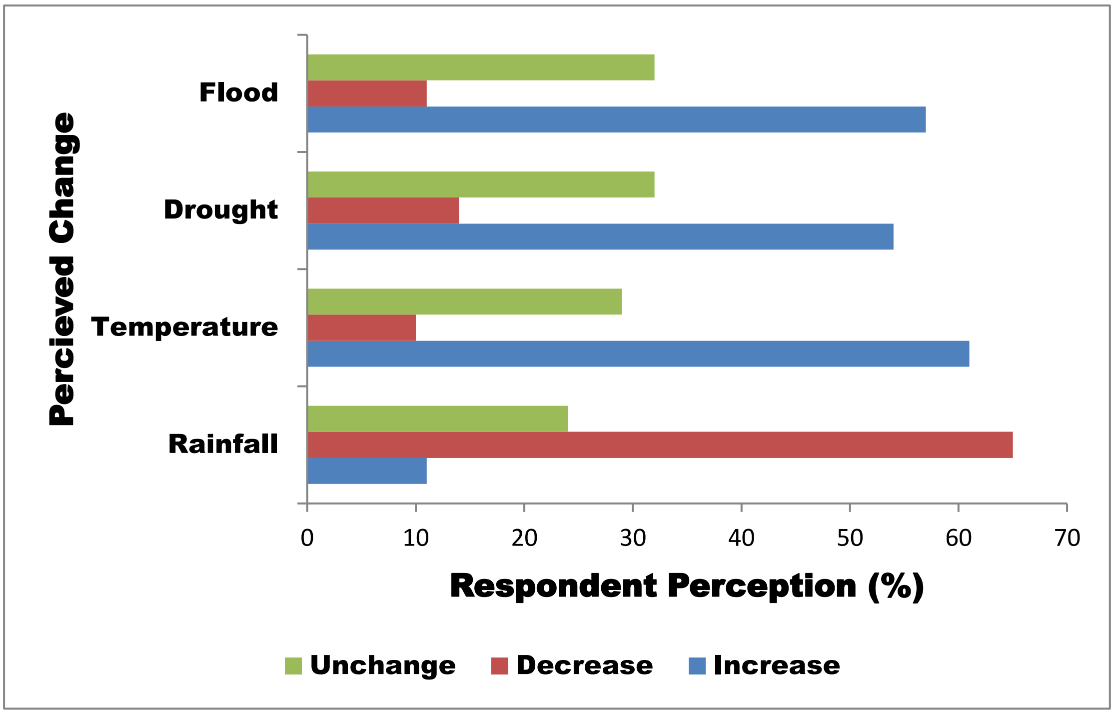

Figure 3: Farmer's perceptions of climate change

However, the present wildlings and few plantations of the species make it impossible to meet the market demand. Also, 96.1% of the farm families investigated reported that in recent years, the productivities of *Cola nitida* have been declining. The ecosystem and environmental benefits of the species were confirmed by the majority (89.6%) of the respondents; the benefits varied from soil erosion control, microclimate amelioration, windbreaks, aesthetic values, and shade amongst others. Also, *C. nitida* trees have cultural and social benefits in the communities studied. The fruit of the species is highly valued during ceremonies and traditional religious rites (Table 2). The social values of *C. nitida* include use at political meetings, naming, and wedding ceremonies. etc.

The respondents validated the species' potentials in income generation. Income from a single tree varied from ₦50,000 ($140) to ₦100,000 ($280) in a fruiting season (Table 3).

Table 2: Respondents perception on demands and importance of *Cola nitida*

	N = 280	(%)
Is there ready market for *Cola nitida* fruits		
Yes	269	96.1
No	11	3.9
Total	280	100
Do you think *Cola nitida* has any benefits to the environment and ecosystem		
Yes	250	89.6
No	11	3.9
No response	18	6.4
Total	280	100
Benefits of *C. nitida* to the environment and ecosystem		
Microclimate amelioration	143	51.2
Shade	231	82.6
Control soil erosion	206	73.6
Aesthetic value	79	28.3
Windbreak	148	52.9
No response	29	10.4
Cultural values of *C. nitida*		
Wedding ceremony	280	100
Naming ceremony	280	100
Burial ceremony	270	96.4
Appealing the gods	260	92.8
Other uses	20	7.1
The social values of *C. nitida*		
Association ceremony	165	58.9
Town meeting	251	89.6
Political meetings	4	2.1

About 60% of the respondents make less than ₦50,000 sales from a single tree in a fruiting season, while less than 24% of the others make a sale of over ₦50,000 ($140) in cash from one standing tree in one fruiting season (Table 3). The impacts of climatic factors in the natural regeneration of the species were pointed out by the respondents. Temperature and rainfall patterns have influenced the raising of the species as attested to by the respondents (96%, n = 269). However, they were unable to authenticate how the factors were influencing the fruiting pattern of the species. Among all the climatic effects, drought, precipitation, flood, and temperature were reported to be the most significant.

It has been observed that the price of Kola fruits has gone up in the study areas. About (31.5% n= 80) of the respondents mentioned deforestation as an important factor accounting for the increasing cost of Kola. Other factors mentioned include seasonal variation (72%, n= 202), reduced fruit size, and increased seasonal variability (13.6%, n = 269). The majority of the farmers (75.4%, n= 211) believe that the demand for *C. nitida* fruits is increasing. The study showed farmers currently not cultivating *C. nitida;* available stands were those that grew naturally and a few others that were inherited from grandparents. (Field survey).

Table 3: Factors affecting the prices of *Cola nitida*

	Number	(%)
Annual Income from the sale of *Cola nitida* (₦)		
≤ 50,000	169	60.4
50,000-100,000	67	23.9
No response	44	15.7
Total	280	100
Factors affecting the price *Cola nitida* fruits		
Season variability (temperature and rainfall intensity)	202	72
Deforestation	88	31.5
Fruit taste	76	27.2
Fruit size	125	44.7
Drought	64	23
Flooding	78	27.9
Total	280	100
Future trend of demand for *C. nitida* fruits		
Increasing	211	75.4
Decreasing	29	10.4
Static	40	14.3
Total	280	100

The influence of climate change on benefits derived from *C. nitida.*

The result of Chi-Square test revealed that all the socio-demographic characteristics tested in this study significantly ($p<0.05$) influenced the perception of farmers on the effects of climate change and/or variability and benefits derived from *Cola nitida* (Table 4). A similar trend was observed in farmers' perception of the future demand, cultivating, and benefits derived from the *C. nitida* (Table 4).

The study showed that respondents' age range, level of education, and primary occupation determined their view on the demand for *C. nitida* fruits, their view on planting *C. nitida* tree, and their perception of temperature and rainfall are likely to influence the availability and benefits derived from the species. In contrast, the marital status of the farmers did not influence their view on whether or not temperature and rainfall influence the availability and benefits derived from *C. nitida*.

Table 4: Chi Square results of farmers' perception on demand and influence of climate change of benefits derived from C. nitida.

Items	†Factors	df	X^2 Values	P- value
Future demand for *C. nitida* fruits	A	8	183.22	0.00*
	S	2	7.06	0.02*
	MS	2	34.76	0.00*
	HS	4	85.40	0.00*
	EL	56	396.59	0.00*
	PO	10	52.39	0.00*
Currently planting *C. nitida* tree	A	8	42.65	0.00*
	S	1	3.39	0.06 ^{ns}
	MS	1	11.56	0.00*
	HS	2	4.19	0.12^{ns}
	EL	4	39.53	0.00*
	PO	5	22.38	0.00*
Change in temperature and rainfall influence the availability and benefits derived from *C. nitida*	A	4	59.96	0.00*
	S	1	8.63	0.00*
	MS	1	2.39	0.12 ^{ns}
	HS	2	1281	0.00*
	EL	4	23.69	0.00*
	PO	5	32.97	0.00*

†Key: **A**= Age, **S**=Sex, **Ms**=Marital status, **HS**= Household size, **EL**= Educational level, **PO**= Primary occupation *Significant at p<0.05, ns= not Significant at p>0.05.

Farmers' perception of climate change *on Cola nitida*

The results of the multinomial regression revealed that all the five explanatory variables significantly influenced the respondents' perception of climate change in the study area. The regression analysis indicated that age, marital status, gender, level of education, and household size were the main factors significantly ($p<0.05$) influencing respondents' (farmers') perception of climate change (Table 5a).

The results revealed that the education level and age of farmers influenced their decision that there is a decrease in recent rainfall pattern and the rates of flood and drought are increasing. The farmers reported that currently, the rate of drought, temperature, and strong wind are increasing as a result of climate change. Educational level significantly influenced the farmers' perception; the probability of observing changes in climatic events increased with the level of education of the farmers. The educational level also influenced respondents' decision on the decrease in rainfall pattern, increase in drought, flood, and strong wind. The gender and household size of the respondents influence their view and the way they perceived the climatic variables. The ages of the farmers also significantly influence their perception and the way they perceived climatic variables; the results showed that climatic variables were perceived more by the young active and adult farmers than the older farmers (Table 5b).

Perceived causes and impacts on ecosystem services delivery of *C. nitida*

The farmers were aware of climate change, but they were not aware of the main and basic drivers and causes of climate change.

Table 5a: Regression analysis of *Cola nitida* farmer's perceptions to climate change

Covariance	Decrease	Unchanged
(A) Rainfall		
Number of observations	280	
Residual Deviance	260.094	
AIC	284.094	
Pseudo R^2	0.467	
Age	2.802(0.975)	1.609(0.861)*
Sex	0.493(0.812)	0.110(0.684)
Marital	-0.034(1.097)	0.049(0.865)
Household_Size	0.863(0.736)	0.636(0.638)
Educational_Level	-1.049(0.644)*	-0.076(0.565)
(B) Drought		
Number of observations	280	
Residual Deviance	268.914	
AIC	292.914	
Pseudo R2	0.363	
Age	0.174(0.893)*	-0.285(0.438)
Sex	-1.918(0.991)*	-0.296(0.405)
Marital	2.898(1.239)**	0.986(0.546)**
Household_Size	1.057(0.952)	-0.137(0.345)
Educational_Level	0.517(0.607)	0.468(0.316)*

**, * Significant at 1 and 5 probability level, respectively

Table 5b: Regression analysis of *Cola nitida* farmer's perceptions to climate change

Covariance	Decrease	Unchanged
(C) Flood		
Number of observations	280	
Residual Daviance	148.97	
AIC	172.97	
Pseudo R^2	0.447	
Age	-0.422(1.031)	-2.106(0.740)
Sex	-0.362(0.952)	-0.508(0.639)
Marital	0.672(1.229)	1.769(0.698)
Household_Size	0.168(0.840)	0.722(0.544)*
Educational_Level	-0.872(0.713)**	-0.231(0.529)
(D) Temperature		
Number of observations	280	
Residual Daviance	164.29	
AIC	188.29	
Pseudo R^2	0.436	
Age	0.169(1.063)	-1.895(0.641)
Sex	0.132(0.914)	-0.778(0.613)
Marital	0.613(1.179)	1.396(0.707)**
Household_Size	-0.504(0.836)	0.903(0.504)*
Educational_Level	0.478(0.738)	-0.316(0.485)**
(E) Wind		
Number of observations	280	
Residual Daviance	249.19	
AIC	273.19	
Pseudo R^2	0.397	
Age	-0.296(0.858)	-0.710(0.463)*
Sex	-1.670(0.949)*	-0.947(0.456)**
Marital	2.036(1.090)*	0.501(0.633)
Household_Size	0.813(0.818)	0.555(0.384)*
Educational_Level	1.231(0.678)**	0.259(0.335)

**, * Significant at 1 and 5 probability level, respectively

All the respondent (100%) revealed during FGD that the causes of climate change are deforestation, urbanization, and human development activities. Some of the respondents believe that climate change is a result of God's will. They reported that changes in rainfall patterns had negative influences on the fruiting pattern of *C. nitida* and that kola production is directly related to water availability in the study area. The farmers revealed during FGD that increases in temperature, drought, flood, and wind usually have significant influences on the fruit production of *C. nitida* and could reduce the ecosystem services provided by this species. All of the farmers interviewed ascertained that the rainy season plays a major role in the fruit production of the species.

DISCUSSION

The farmers highlighted the ecosystem services provided by *C. nitida* including productivity services, supporting, cultural, and regulating services. Hundred percent (100%) of the farmers' interviewed across the study area reported that they are aware of climate change and they believed that it has a negative influence on the productivity of *C. nitida* in Nigeria. They believe that the causes of climate change are deforestation, urbanization, and human development activities, this was revealed during the focus group discussion (FGD).

It was revealed they recently, the farmers have been observing climate changes, they identify climatic factors such as changes in temperature, drought, flood, and rainfall pattern. But they identify climatic factors such as drought, flood, variability in rainfall pattern, and increase in temperature as the most significant sign.

The finding shows that farmers are well aware of climate change and its effects on *C. nitida*, this is in agreement as reported by Fotelli, (2021), the study reported that there are clear effects of climate change on forest trees' function, evidenced by different responses on genes expression, biochemical, and physiological levels. A similar report was documents by Blanco *et. al* (2021). The implication on the similarity of the results could be that the studies was conducted across similar rural formers.

The findings are also in the same direction with previous reports by Sanogo *et. al*. (2017) and Agwu *et. al*. (2018), Ansari *et. al*. (2018), which revealed that *C. nitida* farmers in Nigeria are aware of climate change, but how the climatic variables such as rainfall patterns, drought, flood and temperature influences plant species is unclear. In this study, farmers mentioned recent, increases in frequency and intensity of temperature and flood, and drastic decline in rainfall duration as the main determinants of climate change. This result is in agreement with the findings of Akponikpe *et. al*. (2010), who reported increases in temperature and the number of hot days in West Africa.

The respondents investigated revealed that in recent years, the productivity of *C. nitida* trees has continued to decline. The results corroborate the reports of Maranz (2009) and Gonzalez *et al*. (2012), that climate induces a decrease in water availability and increase in wind speed which usually results in poor fruit formation and reduced yield of trees. Also, this study revealed that farmers' demographic characteristics significantly influenced their perception of climate change. . It was observed that of the six explanatory variables analyzed in this study (namely, age, sex, household size, educational level, and primary occupation) only marital status did not influence farmers' perception of climate change. The results of multinomial logit regressions showed that all the five explanatory variables such as gender, marital status, age, level of education, and household size are factors influencing farmers' perception and view on climate change. The result of this study revealed that the socio-demographic characteristics influence farmers' perceptions of climate change; corroborating the reports of previous authors (Okonya *et.*

al. 2013; Legesse *et. al*. 2010, Sanga1 *et. al*. 2013, Sahu *et. al*. 2013, Odewumi *et. al*. 2013). This observation, however, contradicts the findings of Odewumi *et. al*. (2013), who found that the explanatory variables such as age, education level, and gender did not influence the perception of farmers on climate change. The discrepancy between the results of the present study and that of Odewumi *et al.* (2013), could be attributed to differences in the socio-demographic characteristics of the areas studied. Odewuni *et. al*. (2013), studied an urban area with farmers with a high level of education compared to our study which was carried out mainly in rural areas.

As confirmed by logit regression, the age and sex of farmers are good predictors of their perception of climate change. Another important factor associated with the perception of all tested indicators of climate change such as a change in rainfall pattern, drought, and increase in temperature, flood, and strong wind in the study area is the educational level of the respondents. The results agreed with that of previous studies (Varadan *et. al*. 2014), which indicated that older farmers have been exposed more to changes in the climate than younger farmers. The finding also agrees with Habiba *et. al*. (2012), who reported age and level of education as major factors influencing farmers' perception of climate change. The present study revealed that farmers are not currently cultivating *C. nitida* but are willing to grow the species if they get the needed support from government agencies and policymakers. The educational level of farmers is an important parameter and a good predictor influencing farmers' perception. It influences the farmers' decision and opinion on whether or not there is a decrease in rainfall pattern, increase in drought, temperature, and flood in Nigeria in recent years. The findings also agree with Habiba *et. al*. (2012), who reported that education significantly influenced farmers' perception of climate change. The authors further asserted that educated farmers perceived climate change more because they had several ways to document and remember past events.

CONCLUSION

This study investigated the influence of climate change on ecosystem services provided by *C. nitida* in Nigeria and has highlighted various ecosystem services provided by the species. The results have listed the perceived causes of climate change and how it influences ecosystem services. The results revealed that farmers have observed an increase in temperature, drought frequency, and decrease in rainfall patterns in the study area. The various characteristic that influences the farmers' perception of climate change in Nigeria was listed as temperature, drought, flood, and change in rainfall pattern. Farmers should be education and encouraged to domesticate more *C. nitida* trees on their farms and home gardens as a way forward to a future with a stable supply of goods and services and the provision of ecosystem services for their livelihood. Appropriate incentives should be given to the farmers to propagate *C. nitida* on their farms. Farmers should be educated on the main causes, mechanism and derives of climate change in Nigeria. Rural communities should be supported to establish plantations and possibly incorporate kola into agroforestry practices. This will guarantee a future stable supply of the species and enhance the provision of the ecosystem services they render.

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