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ORIGINAL RESEARCH ARTICLE

Understanding factors intercepting response of rice farmers to climate change in Ebonyi State, Nigeria

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ABSTRACT

Understanding factors intercepting the response of rice farmers to climate change in Ebonyi State, Nigeria, was investigated. A total of 70 rice farmers were sampled using a multi-stage sampling technique and administered a questionnaire. Primary data was collected and analyzed using descriptive statistics (mean, frequency, percentage, chart) and an ordinary least squares multiple regression model. Results show that the rice farmers cultivated on small land holdings, were relatively educated, sourced their land via inheritance, and had 16 years of farming experience. Results reveal that 72% of the rice farmers are highly aware of climate change, while 17% and 11% are relatively aware and not aware, respectively. Temperatures, rainfall, and the number of rainy days have positive effects on rice production, while sunshine hours and relative humidity have negative effects on rice production. Age, gender, education, farm size, extension contacts, and participation in workshops were significant variables influencing rice production in the state. Capital, crude implements, pests and diseases, poor soil, lack of incentives, and cultivation systems were the non-climatic factors that influenced rice cultivation in the state. Farmers were recommended to embrace climate-smart cropping systems and seek early climate change information to mitigate the adverse effects of climate change on rice cultivation.

Keywords: rice farmers; climate change; multi-stage sampling; logit model; Ebonyi State

1. Introduction

Due to its sensitivity and fragility to changes in rainfall and high ambient temperatures, climate change is one of the most serious risks to Nigeria's agricultural industry and food security[1]. For example, increased temperature reduces the yield of desirable crops, while promoting the growth of weeds and pests, and changes in precipitation patterns increase the risk of short-term crop failure and long-term production declines[2]. As a result, temperature variability poses a significant challenge to the production of food. Climate change-related issues are now top-of-mind globally, particularly in relation to agriculture. This is due to the fact that climate change is thought to be seriously impeding agricultural development, food security, and the general human condition of livelihood[3]. Agriculture, especially rainfed agriculture, depends on favorable climate conditions to be productive and is threatened by a changing climate, especially

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if it brings with it unfavorable conditions. Both climate change and weather are independent occurrences that have a variety of potential positive or negative effects on agricultural activities. While a continuous trend in any climatic element over a long period of time, not less than 30 years, is considered to be the cause of climate change, it may be argued that the initial climate has changed significantly[4]. There are two ways that the climate might change: naturally or as a result of human activity. However, the release of greenhouse gases from human activities, with carbon dioxide serving as the main greenhouse gas, is largely responsible for the current change in climate[5]. As part of the carbon cycle, which is the natural movement of carbon among the atmosphere, seas, soil, plants, and animals, carbon dioxide (CO_2) is naturally present in the atmosphere. However, human activities are changing the carbon cycle because they increase the amount of CO_2 in the atmosphere as a result of industrial endeavors and because they affect how well natural sinks, such as forests, are able to absorb CO_2[3]. According to scientific data, the Earth’s atmosphere’s concentration of greenhouse gases, primarily carbon dioxide, has been rising. Although there are many different natural sources of carbon dioxide emissions, Chen et al.[5] argue that human-related emissions are to blame for the atmosphere’s rise since the start of the industrial revolution. Agricultural cultivation is still subject to climate change as these changes proceed; this change could either be beneficial or detrimental depending on the state's level of climate change[6]. Some of the most significant and immediate effects of climate change are anticipated to be on agricultural and food systems throughout the ensuing decades[6].

One of the most important cereal crops farmed worldwide is rice in particular. About 3 billion people worldwide eat rice every day[7]. With its significance as a staple meal and as a significant source of calories for many households, particularly in Ebonyi State, rice is a significant food crop in Nigeria. Ebonyi State in Nigeria is well known for its effective rice farming, which uses primarily marsh terrain. Over 90% of her rural population is involved in rice farming, which is one of their main food supplies and a source of farm revenue for maintenance and survival[8]. Despite rice’s significance for the state, climate change poses a threat to its yield and production. In the state right now, climate change unpredictability and the prevalence of extreme weather events are negative omens since they determine how rice is grown and how vulnerable farmers are to climate shocks and/or dangers. Concern is growing among the rural farmers who depend on rice cultivation for their livelihood and economic sustenance in the state. The state’s local food security has been further harmed by the diminishing output. This is consistent with the Food and Agriculture Organization’s claim that Nigeria’s cereal self-sufficiency has been declining, leading to a rapid increase in grain imports, particularly rice imports, which climbed by 170 percent over the previous five years[9]. Climate change variations have an impact on rice agriculture, which causes food shortages and low supply. For example, changes in temperature, precipitation, relative humidity, evaporation, frost, and wind all have a terrible impact on rice output[10]. However, Nigeria was chosen as a case study because of the devastating effects of climate change on Nigeria's agriculture and other economic sectors. No doubt, climate change has ravaged Nigerian agriculture (crop production, animal production, fishery and aquaculture, horticulture, etc.), leaving adverse consequences and negative impacts, hence lowering the contribution of agriculture to the gross domestic product (GDP) and impeding the development of the entire agriculture sector. Furthermore, cases of climate change incidences in Nigeria have been empirically reported widely by the IPCC, FAO, and several authors, making Nigeria an interesting location to study.

Albeit, several research studies have been carried out on issues related to climate change in Nigeria, Africa, and other parts of the world. Interestingly, none of these studies explored the concept of “understanding factors intercepting the response of rice farmers to climate change in Ebonyi State, Nigeria”, thus the novelty and originality of the study. This scenario created a huge gap in knowledge, and hence this study was conceived to close out the gap and therefore presents an objective empirical assessment of "understanding factors intercepting the response of rice farmers to climate change in Ebonyi State, Nigeria".

2. Materials and methods

The study was carried out in Nigeria's Ebonyi State's Ikwo Local Government Area. Ikwo, one of Ebonyi State's local government areas, is situated between latitudes 603I11IN and 809I46IE. Twelve independent communities make up the Ikwo Local Government Area. Its land area is roughly 5000 square kilometers, and its borders with Izzi in the north, Ezza in the west, Cross River State in the south, and Abakaliki in the east all converge there. The temperature in the area is 30 °C. The rainfall pattern is bimodal, with maxima in July and September and a maximum of 2500 mm. They have historically been farmers and raise livestock along with the following crops in considerable quantities: rice (ereshi), yams (nji), cocoyams (nkashi), cassava (njakpu), potatoes (ogogo), groundnuts (ashimoko), soya beans (azaku), guinea corn (igeri), and bambara nuts (akpanyinko). A multistage sampling technique was used for sample selection. The first stage involved a random selection of four autonomous communities in the Ikwo Local Government Area. The second stage progressed with another random selection of four villages from the selected communities, giving a total of 16 villages. In the third stage, five rice farmers were randomly selected from the 16 villages, making a total of 80 respondents for the study. The list of rice farmers was provided by the Agriculture Development Programme Coordinators in the local government area. Primary data was collected using the research instrument (questionnaire), which was administered in person through a personal interview and focused group discussion. Out of the 80 questionnaires distributed, only 70 were found useful for data analysis. However, before actual data collection, the questionnaire was pre-tested using a pilot survey to determine its reliability and content validity. Data were analyzed using descriptive statistics, such as the mean, frequency, and percentages, and the logit regression model.

The logit regression model is expressed as:

$$Y_i = \log(p/1 - p) = F(X_i, b) + e \quad (1)$$

i.e., the logit of a number p between 0 and 1 is given by

$$(p) = \log(p/1 - p) = \log(p) - \log(1 - p) \quad (2)$$

where P is the probability while $(1 - p)$ is the corresponding odds, and the logit of the probability is the logarithm of the odds.

Y_i= Observable dummy variable that indexes response to climate change (responded to climate change =1, otherwise =0),

F = Logistic cumulative distribution function,

b = Vector of estimated parameter,

X_i= Independent variables considered, which include,

X_1 = Age (Years),

X_2 = Education (No of years spent in school),

X_3 = Household size (No of persons),

X_4 = Off-farm activities (Engaged =1, otherwise=0),

X_5 = Farm size (ha),

X_6 = Participation in climate change workshop (No of times participated),

X_7 = Access to extension services (No of visits),

X_8 = Farming experience (No of years),

X_9 = Access to climate change information (Accessed =1, otherwise=0),

X_{10} = Climatic events (Affected =1, otherwise=0),

e = error term.

Again, ordinary least squares multiple regression technique on impacts of climate change on sustainable crop production was further expressed as follows:

$$Y = f(X1, X2, X3, X4, X5, X6) + e \quad (3)$$

where
Y = Output (kg),
X_1 = Temperature (oc),
X_2 = Rainfall (mm),
X_3 = Number of rainy days (number of times),
X_4 = Evaporation rate (mm),
X_5 = Sunshine hours (h),
X_6 = Relative humidity (%),
e = error term.

3. Results and discussion

3.1. Socio-economic characteristics of rice farmers

The socio-economic characteristics of rice farmers are presented in **Table 1**. The table shows that the majority of the farmers were within the age bracket of 51–60 years, with a mean age of 52 years. This obviously implies that the farmers were advancing in age but still physically strong to carry out their farming operations. An increase in age engenders in-depth knowledge of agricultural operations, which enhances improved farm output and income[11]. The majority of rice farmers were female, 67.1%, relative to the males, 32.9%. This implies that rice production was dominated by the female farmers in the state. This could be due to their over-involvement in rice farming relative to the male farmers, who could be engaged in non-agricultural occupations. Again, rice farming seems to be less strenuous, hence the involvement of more women than men[12]. Majority of farmers were married, 58.8% and the singles, 7.1%. Also, about 11.4% were divorced, and 22.9% widow/widower. This implies that marriage supports more of the family labour used in rice production. This also shows that the married ones are more focused, dedicated, and committed to their farming enterprise than the single farmers[13]. About 22.9% of farmers had primary education, 11.4% had tertiary education, and 14.3% had non-formal education. Thus, the majority of farmers, 51.4%, had secondary education; this implies that the rice farmers were relatively literate to understand farm production principles and techniques that are targeted towards improved rice production[14]. The majority of rice farmers, 74.2%, had a household size between 5 and 8 persons, with a mean household size of 7 persons. This implies that the household size of the rice farmers was relatively large and could support their farming strength and production activities. A sizable household provides more family labour relative to households with smaller household sizes[15]. The majority of rice farmers, 92.8%, were fully involved in farming operations and/or activities, while about 7.1% of them were engaged in farming activities and other related occupations. It should be noted here that these engaged occupations serve as sources of livelihoods and income earnings for farm families[6]. The majority of rice farmers had farm sizes within 0.1–1.0 hectares, with a mean hectare of 0.7. This implies that rice farmers cultivated less than 1 hectare of farmland. This could be attributed to the scarcity of land in the area as well as land fragmentation, which only accommodates a small area of cultivation[9]. About 18.6% of rice farmers had between 3–4 physical contacts with extension agents, while the majority of them, 81.4%, had between 1–2 physical contacts. The mean extension contacts were approximately 2 contacts, which implies that rice farmers had low extension contacts with the extension agents. This could be attributed to sometimes the un-seriousness of the extension agents with their job responsibilities and/or assignments given to them. Also, poor logistics could contribute to these anomalies[16]. The table shows that 11.4% of the farmers had no cooperative membership, while a majority (88.6%) belong to rice cooperative societies. This implies that a majority of rice farmers had access to information, farming inputs, credit facilities, and others. Belonging to a cooperative group offers one the opportunity to relate to and interact with other farmers across and within their territory and to obtain certain useful information and agricultural inputs that would have been difficult to access individually[6]. The majority of rice farmers (77.1%) participated in workshops or training between 3 and 4 times per cropping season. About 21.4% participated between 1 and 2 times. The mean participation value of 3.0 shows that, on average, rice farmers participated at least three times per cropping year. Participation in these trainings and workshops instills new farming skills, knowledge acquisitions, and an adequate understanding of crop production principles, which enhances yield performances[17]. The majority of rice farmers, 72.9%, had farming experience between 11 and 20 years, with a mean farming experience of 16 years, implying that rice farmers were well experienced in their farming operations and rice cultivation. Farming experience exposes farmers to deeper knowledge and understanding of farm operations and production activities. This increases farm production and improves farm performance on both a short- and long-term basis[18]. About 5.7% accessed their capital from banks, 18.6% from friends/relatives, 48.6% from personal savings, and 21.4% accessed their capital from cooperative societies. The implication is that rice farmers accessed their farm capital mostly via personal savings, considering the fact that other sources may not be as easily accessible as expected[6]. About 4.3% got their land via pledge, 10.0% got it through purchase, 2.9% got it through gifts, 8.6% got it through lease or rent, and 74.3% got it via inheritance. This implies that the land acquisition in the area is primarily via inheritance, as this source of land sometimes characterizes rural land ownerships[18]. The majority of the farmers, 71.4%, utilized family labour, 17.1% made use of hired labourers and the remaining 11.4% used both family and hired laborers. This implies in general that the labour used in the area was mainly family labour relative to the hired labour, this could be probably due to the higher fares charged by hired labourers[14].

Table 1. Socio-economic characteristics of rice farmers.

Age	Frequency	Percentage
20–30	09	12.9
31–40	16	22.9
41–50	10	14.3
51–60	35	50.0
Mean	52	
Sex		
Male	23	32.9
Female	47	67.1
Marital status		
Single	05	7.1
Married	41	58.8
Divorced	08	11.4
Level of education		
Primary	16	22.9
Secondary	36	51.4
Tertiary	08	11.4

Table 1. (*Continued*).

Level of education		
Non formal	10	14.3
Household size		
1–4	15	21.4
5–8	52	74.2
9–12	03	4.3
13–16	-	-
Mean	7	
Occupation		
Farming only	65	92.8
Farming and others	05	7.1
Farm size		
0.1–1.0	54	77.1
1.1–2.0	12	17.1
2.1–3.0	2	2.9
3.1 & above	2	-
Mean	0.7	
Extension contacts		
1–2	57	81.4
3–4	13	18.6
5–6	-	-
7 & above	-	-
Mean	1.6	
Cooperative membership		
Yes	62	88.6
No	08	11.4
Participation in workshop/training		
1–2	15	21.4
3–4	54	77.1
5–6	01	1.4
7 & above	-	-
Mean	03	
Farming experience		
1–10	17	24.3
11–20	51	72.9
21–30	2	2.9
31–40	-	-
Mean	16	
Source of capital		
Banks	04	5.7
Friends/relatives	13	18.6

Table 1. (*Continued*).

Source of capital		
personal savings	34	48.6
Co-operatives society	15	21.4
Other	04	5.7
Source of land		
Inheritance	52	74.3
Lease/rent	06	8.6
Gift	02	2.9
Purchase	07	10.0
Pledge	03	4.3
Source of labour used		
Family	50	71.4
Hired	12	17.1
Both	08	11.4

Source: field survey data, 2023.

3.2. Awareness of rice farmers to climate change

The awareness of rice farmers about climate change is shown in **Figure 1**. The figure reveals that 72% of rice farmers are highly aware of climate change, while 17% and 11% are relatively aware and not aware, respectively. This implies that the majority of rice farmers are aware of climate change, and this is notably because they have experienced climate change disturbances and negative effects on their crop yield, output, and farm production in general. Awareness of climate change further implies that farmers are leveraging climate change information to mitigate its ugly impacts on their crop production[18].

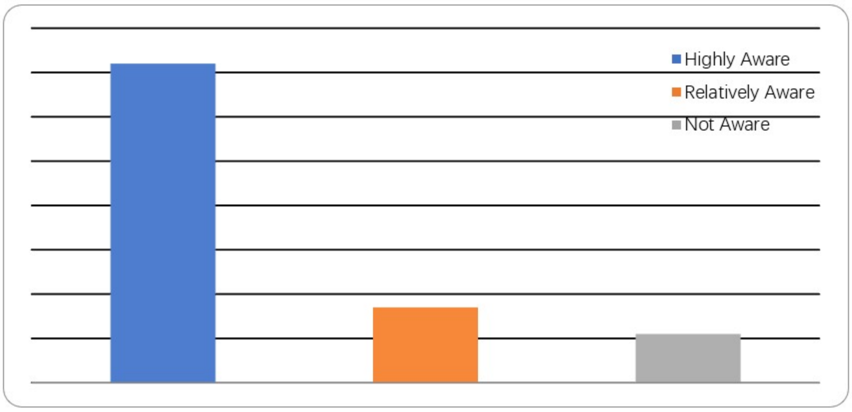

Figure 1. Awareness of rice farmers to climate change.

3.3. Climate variables influencing rice production

The climate variables influencing rice production are shown in **Table 2** and were determined by the double-log functional form, taking into cognizance its number of significant variables, highest *F*-value, and R^2. The R^2 value of 0.8501 indicated that 85% of the total variations in the endogenous variable were fully explained by the climate variables observed. The fact that the temperature was negative and significant suggests that a rise in temperature reduces the yield of the rice crop. A rise in soil temperature encourages the growth of soil pathogens, which in turn spawn insect pests and illnesses that harm rice crops and reduce their long-term viability. High temperatures hinder the reproductive and developmental stages of rice seedlings, which lower plant height and root extension, resulting in subpar growth and production[19]. Rainfall was negative and substantial, indicating that a rise in precipitation lowers rice production. Increased rainfall poses a risk to rice agriculture through soil erosion, water logging, and percolation, which can have disastrous impacts on root and shoot growth. The general sustainability of rice crop production is hampered by increased rainfall, which damages rice field crops that have been sown and lowers their yield and market prices[20]. Increased rainfall intensity can potentially cause flooding, which will lower rice crop output and worsen the state's local food security situation. The number of rainy days was negative and substantial, suggesting that an increase in the number of rainy days affects the yield of rice and the sustainability of crop outputs by heavily flooding rice farmlands and eroding away the top vegetative soils[9]. It also makes the soil less productive and infertile by reducing its nutrient levels and budget composition[21]. There are more rice diseases and pests harming rice crop productivity as a result of an increase in the number of wet days, which also supports the development of rice crop diseases. Indicating that a percent increase in sunshine hours enhances rice output, sunshine hours were positive and significant. Sunlight is essential for crop growth and development as well as for crop plants' photosynthetic processes, which increase crop yield and output while maintaining sustainability[16]. In order to transform carbon dioxide and water into carbohydrates and oxygen, plants require energy. Crop biomass is increased by using the carbohydrates created by photosynthesis for vegetative and reproductive growth[22]. The importance of sunlight in crop production cannot be overstated, especially during photosynthesis. Photosynthesis is the process by which plants and other autotrophic organisms transform light energy, typically from the sun, into chemical energy that can be used to synthesize carbohydrates and support the microbial activities of soil organisms. Relative humidity was significant and positive, indicating that a 1% increase in relative humidity would boost rice crop yield by 99.3%. Relative humidity raises the moisture content of farmlands, particularly in dry seasons, leading to an increase in the production of rice crops and sustainable output. The relative humidity of a plant's environment fosters transpiration, leaf growth, photosynthesis, crop pollination, and economic yield. It boosts soil moisture availability at all times and promotes seed growth and germination[23].

Table 2. Effect of climate change on vegetable production.

Variable	**Linear**	**Semi-log**	**Double-log**	**Exponential**
Constant	−0.8942 (−2.014)**	−0.8324 (−1.408)	−0.731 (−1.070)	−0.9522 (−1.192)
Temperature (X_1)	−0.9235 (−0.011)	−0.821 (−2.301)**	−0.4562 (−3.412)***	−0.5321 (−1.992)*
Rainfall (X_2)	−0.6344 (−1.532)*	−0.5415 (−1.091)	−0.6789 (−4.410)***	−0.8325 (−1.203)
Number of rainy days (X_3)	−0.7489 (−1.193)	−0.7122 (−4.251)***	−0.6002 (−1.902)*	−0.6423 (−2.308)**
Evaporation rate (X_4)	−0.6391 (−0.011)	−0.8325 (−3.602)***	−0.6382 (−0.401)	−0.7124 (−1.224)
Sunshine hours (X_5)	0.9833 (2.360)**	0.9232 (1.091)	0.5473 (4.772)***	0.9002 (4.202)***
Relative humidity (X_6)	0.7783 (1.003)	0.9314 (1.816)	0.9933 (2.107)**	0.6418 (1.099)
R^2	0.7704	0.7905	0.8501	0.7841
F-ratio	14.81***	17.30***	26.88***	10.66***

Source: field survey data, 2023. ***, **, * significant at 1%, 5%, and 10%.

3.4. Determinants of response mechanism of rice farmers to climate change

The determinants of the response mechanism of rice farmers to climate change are presented in **Table 3**. The logit model was used to examine the determinants of the response mechanism of rice farmers to climate change. The R^2 value of 0.8911 shows that 89.11% of the total variations in the response mechanism of rice farmers were explained by the explanatory variable investigated. The F-value of 152.102 was significant at 1%, indicating that the model was a good fit. The age coefficient of the farmers was negative and significant at 1%; this implies that a percentage increase in the age of rice farmers will slow down their responses and actions. It should be noted that as farmers' age increases, it becomes difficult for them to respond quickly to adverse climate effects[6]. The gender coefficient of rice farmers was negative and significant at 1%, this implies that the female farmers cultivated more rice than their male counterparts. Empirical studies have revealed the predominance of female farmers in crop production, arising from gender equity and equality[16]. This further implies that the female rice farmers responded quickly to the changing climate relative to the male farmers. The level of education coefficient was positive and significant at 1%; this implies that any increase in the educational attainment of rice farmers will increase their likelihood of responding quickly to climate change. Education enhances one’s knowledge and equips farmers to access various response mechanisms for overcoming climate change[17]. The coefficient of farm size of rice farmers was positive and significant at 5%; this implies that any increase in the farm size of rice farmers will correspondingly increase their tenacity to respond to climate change. Increased farm sizes are very important in this era of changing climates because they encourage large-scale cultivation that withstands the events of crop failure via climate change[16]. The coefficient of extension contacts was positive and significant at 5%; this implies that an increase in the extension contacts of rice farmers increases the likelihood of the farmers responding urgently to climate change issues. Extension contacts enhance knowledge acquisition and expose farmers to new practical ways of responding to climate change. The coefficient of participation in workshops and trainings was positive and significant at 1%; this implies that increased participation in workshops and trainings increases the chances of rice farmers responding quickly to climate change[24]. That is, a percentage increase in participation in workshops and trainings will result in about 790.04% of people responding to climate change issues. Participation in workshops and trainings exposes farmers to new innovations, recent climate change responses, and adaptation strategies and techniques required to mitigate adverse climatic effects. The coefficient of farming experience was positive and significant at 5%; this implies that a 1% increase in the farming experience of rice farmers will lead to a corresponding increase of about 900% in the in the chances of responding to climate change in the area. An experienced farmer stands better chances of responding to climate change than an inexperienced farmer[25]. Again, farming experience helps farmers overcome certain inherent farm production challenges, such as climate change, etc.

Table 3. Determinants of response mechanism of rice farmers to climate change.

Variables	Coefficients	*t*-values	S.E
Constant	5.0051	2.1091**	2.3731
Age	−19.3062	−4.3093***	4.4801
Gender	−0.7016	−4.0880***	0.1716
Marital status	10.3066	0.9016	11.4314
Level of education	4.1091	4.2113***	0.9757
Household size	−0.7707	−0.2009	3.8362
Occupation	−6.0313	−0.5552	10.8632
Farm size	0.8324	2.2105**	0.3765

Table 3. (*Continued*).

Variables	Coefficients	*t*-values	S.E
Extension contacts	19.4055	2.0034**	9.6862
Cooperative membership	−4.0554	−1.9101	2.1231
Participationin workshop/training	7.9004	5.0201***	1.5737
Farming experience	9.0036	2.1191**	4.2487
R^2	0.8911	-	-
F-value	152.102***	-	-
N	70	-	-

Source: field survey data, 2023. ***, **, * significant at 1%, 5%, and 10%.

3.5. Non-climatic factors influencing rice production

The non-climatic factors influencing rice production are presented in **Table 4**. Capital and a lack of incentives were observed by all rice farmers, pointing out that these non-climate factors really influenced rice production in the state. Capital is seen as a driving force in the acquisition of farm inputs and materials, and its absence could frustrate farmers overall crop production, leading to poor performances[24]. It is expected that the government and other relevant stakeholders in agriculture should from time to time support farmers with incentives to improve their rice production, but this has over the years been unprovided and ignored, thus negatively influencing crop production. The use of crude implements was indicated by 93% of rice farmers; crude implements create fatigue and slow down the production and productivity of rice farmers. It exhausts the energy and physical strength of the farmers, leaving them worn out, and this decreases their land output and yield[26]. Pests and diseases were observed by 94.3% of rice farmers. The incidence of pests and diseases frustrates the efforts of the farmers, rendering their crop production ineffective, thereby decreasing both yield, productivity, and income. Poor soil was indicated by 78.6% of the rice farmers; nowadays, farmers cultivate in variant soils that are unproductive and infertile, leading to a loss in rice production. Again, the high cost of inorganic fertilizers to support poor soils has further impoverished the soil, making it less productive[3]. Cultivation systems were observed by 72.9% of rice farmers. Farmers use farming cultivation systems that do not support high yield and land productivity; this includes continuous cropping, marginal cultivation, etc., which are known for decreased production and output. Illiteracy was indicated by 71.4% of rice farmers; nothing impedes farm production faster than the low educational attainment of the farmers. Lack of education breeds ignorance in the use and application of productive and high yielding cropping systems, methods, techniques, etc., thereby slowing down crop production[27]. The farmers inability to understand basic farming and production methods makes it difficult for them to increase farm production. The size of the land cultivated was observed by 67.1%; it is a general fact that the smaller the farm, the smaller the yield and farm output. Rural land holdings are characterized by small land holdings, which are inimical to increased crop production. Poor extension visits were attested to by 60% of rice farmers; poor visits by the extension agents hinder knowledge and innovation transfers to the farmers; that is, poor extension contacts lower farm yield and negatively affect farmers' performances[28].

Table 4. Non-climatic factors influencing rice production.

Non-climatic factors	Percentage	Frequency
Capital	70	100
Crude implements	65	92.9
Pests & diseases	66	94.3

Table 4. (*Continued*).

Non-climatic factors	Percentage	Frequency
Poor soil	55	78.6
Lack of incentives	70	100
Cultivation systems	51	72.9
Illiteracy	50	71.4
Size of land cultivated	47	67.1
Poor extension services	42	60.0

Source: field survey data, 2023.

4. Conclusion and recommendation

Climate change has become a reoccurring phenomenon influencing global agricultural production, including rice cultivation, in no small measure. The findings of the study reveal that rice farmers were in prime age (52 years), relatively educated (51.4%), cultivated on small farm sizes (0.7), and had 16 years of experience in rice cultivation. This generally implies that rice farmers were in their productive age and experienced enough in rice farming, as this could trigger efficiency and increased output. The majority of them, 72%, were aware of climate change, and this implies that they are better positioned to mitigate its adverse effects. Temperature, rainfall, and the number of rainy days were negatively related to rice production, while sunshine and relative humidity had a positive relationship. This implies that climate change had dual influences on rice production in the state, and the result differs from other previous studies. Age of rice farmers, gender, education, farm size, extension contacts, and workshop participation were among the variables intercepting the response of rice farmers to climate change in the state. This implies that these variables had both positive and negative effects on rice cultivation, as shown in similar studies. Non-climatic factors such as capital 100%, illiteracy 71.4%, size of land cultivated 67.1%, poor extension services 60%, poor soil 79%, and pests and diseases 94.3% further influenced rice production in the state. These are factors that impeded the cultivation and production of rice in the state. The policy implication of the study remains that rice production in the state was both affected by climate change and non-climatic factors, thereby lowering its contribution to the gross domestic product in the state, and therefore adequate measures should be put in place to reverse this ugly trend. The study recommends rice farmers practice proven and verified climate-smart cultivation systems and seek early climate change information before embarking on rice production. Also, rice farmers should be trained on climate change variations and provided with the needed support via extension services in mitigating climate change.

5. Limitation of the study/further study

The study focused specifically on "understanding factors intercepting the response of rice farmers to climate change in Ebonyi State, Nigeria". I suggest that this study be replicated evenly in several other states of the federation.

Author contributions

Conceptualization, EEO; methodology EEO; software ACTA; validation ACTA and SCO; formal analysis, EEO; investigation, UTA; resources, UTA; data curation, JN and UTA; writing—original draft preparation, EEO; writing—review and editing, UTA and SCO; visualization, RAI; supervision, RAI; project administration, JN and RAI. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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