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Impact of Climate Change On Rice Production in Northern Cross River State, Nigeria

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Abstract:- The need to mitigate the impacts of climate change on rice production requires having information on climate change indicators as well as impacts of such indicators on rice production. This research was designed to determine such indicators and impacts of climate change on rice production. A descriptive survey design was adopted for the study and data was generated by administering questionnaire on a sample of 350 rice farmers randomly sampled from all rice farmers in the study area. Two research questions were answered using mean and standard deviation while a null hypothesis was tested using ANOVA. The result of the study shows that Rice Farmers experience some climate change indicators which have impacts on rice production system. Based on these findings and their associated implications, appropriate recommendations were made among which are: Experts developing agricultural extension programmes on climate change should involve rice farmers who are already aware of climate change indicators for meaningful contribution and effective participation in the programme development process; Agricultural extension agents should identify rice farmers who are already aware of the impact of climate change on rice production for agricultural input supply and other palliatives including subsidies.

Keywords:- *Climate change, Indicators of climate change , Impacts of climate change.*

I. INTRODUCTION

Rice, botanically known as Oryza spps is one of the popular cereals grown and consumed approximately by half of the world's population. Little wonder Food and Agricultural Organization (FAO, 2008) reported that rice ranks as the fourth most important grain crop after maize, sorghum and millet and that it is one of the primary sources of carbohydrates for farmers. Collaborating with the foregoing, Hawksworth (1985) posited that rice is the most important staple food for about half of the human race while Imolehin and Wada (2000) reported that it ranks third after wheat and maize in terms of worldwide production. It is a member of the grass family known as gramineae. According to Erebor (2003), rice cultivation requires temperature of about 20^{o}C -30^{o}C and rainfall of 75cm to 120cm for upland sitting and 250cm for swamp setting respectively. Iwena (2008) in his presentation reported that rice requires temperature of over 20^{o}C, 75cm to 120cm of rainfall for upland production and 250cm for swamp cultivation.

Nigeria is West Africa's largest producer of rice, producing on average of 3:2 million tones of paddy rice and 2 million tones of milled rice annually (Polycarp, 2019). Ironically, Nigeria is the continent's leading consumer of rice, one of the largest producers of rice in Africa and simultaneously one of the largest rice importers in the world (ThriveAgric, 2020). West Africa Rice Development Association (WARDA) as cited in Polycarp (2019) estimated that per-capita rice consumption in Nigeria has nearly doubled between 1980s and 2006, growing from 15.4kg/year to 25.4kg/year. Notwithstanding the above worrisome revelation, ThriveAgric (2020) added that rice generates more income for Nigeria farmers than any other cash crop in the country and that it is the number one staple food in the country.

Nigeria as well as many other countries across the globe has suitable ecologies to boost the production of different varieties of rice to meet domestic demands and even to produce surplus for exports. The country has a potential land area for rice production between 4.6 million and 4.9 million hectares. Unfortunately, only 1.7 million nectars or 35% of Nigeria's total land mass is cropped to rice. The cultivable land to rice is spread over 5 major ecologies namely upland, inland or shallow swamp, irrigated rice, deep water or floating rice and tidal mangrove or swamp. The latter is not fully developed because appropriate technologies are lacking (Singh as cited in Imolehin and Wada ,2000). According to International Rice Research Institute (IRRI ,2013) Nigeria is located in Western Africa, between Benin and Cameroon and has a total land area of 923,768km2 of which only 34.6% is arable land and is contained within a 4,047km land boundary and a coastline of 853km. That the climate in Nigeria varies from equatorial in the south to tropical in the center and arid in the north with an estimated population of 162.5 million in 2011. The author added that rice production environment in Nigeria are rain fed lowland 69.0%, irrigated low land 2.7% and rain fed 28.3%.

Farmers in Nigeria have intensified and expanded rice production on more of their land than ever to take advantage of a surge in price since the country shut its land borders. That the farmers consider this expansion worthwhile despite the absence of machinery or irrigation facilities limited manual labour, little or no spare cash for fertilizers. In support of the above, George (2020) lamented that the situation is too bad that women stressfully hand beat harvested stalks on the ground to separate the grains from the Chaffs.

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IRRI (2013) had reported a gloomy picture about rice production in Nigeria. That rice farmers have limited access to credit facilities and extension services. Worst still is the fact that only about 20,000 tractors are available for all the 14 million farming families or groups. The author concluded that processing capacity is a major bottleneck to increasing the national rice supply. Little wonder Singh et.al as cited in Imolehin and Wada (2000) lamented that rice production increase has however not been enough to meet the consumption demand of the rapidly growing urban population who has a great preference for parboiled rice. That this situation led to acute demand for parboiled rice in 1990 which contrasted with Nigeria's self sufficiency in rice during the 1960s.

Not with standing these production challenges, Polycarp (2019) reported that rice is popularly among the most marketable of all crops in Nigeria. It is both food and cash crop for farmers, contributing to small holders' revenue in Nigeria. Presumably, IRRI 2013 position that consumers preferences are shifting from traditional staples such as cassava, maize and yam to rice may have made it among the most marketable as mentioned above. Premised on the forgoing, it would not be out of place for one to conclude that rice is not only a key source of food but a major source of employer of labour and source of income for the rural poor.

It is highly appalling and regretful for one to understandably analyze the paradox of rice production, consumption and importation situation in Nigeria. For instance, the 360,000 tons of rice produced in the 1960s was enough to meet local demand but the 1.45 million tons produced in the 1990s were not. This worrisome inadequacy propelled importation of rice from 7000 tons in the 1960s to 657,000 tons in the 1990s. This resulted in a serious drain on Nigeria's foreign exchange reserve which stood at 407.5 million US dollars in 1960s but dropped to 58 million US dollars in the 1990s (IRRI, 1991, 1995). The drain on foreign reserve led the Nigerian government to ban rice imports in October 1985. In addition to banning rice importation, the following government programmes and policies were introduced to inter-alia encourage and boost local rice production. National Accelerated Food Production Project (NAFPP) set up in 1974; World Bank Assisted Development Programme set up in 1975; Operation Feed the Nation (OFN) in 1976; River Basin Development Authority (RBDA) in 1977; Back to Land Program (BLP) and the Directorate of Food, Roads and Rural Infrastructure (DFRRI) both introduced in 1988 and later on the National Land Development Authority (NALDA) in 1995.

In spite of all these programmes, the production of local rice did not keep up with the domestic consumption demand of the Nigeria populace and consequently, rice importation resumed. While Singh et.al (1997) lamented the resumption of rice importation generally, Imolehin and Wada (2000) attributed such resumption to inconsistency in government policies and programmes. That Nigerian farmers reacted to the ban on rice imports in 1985 by intensifying rice cultivation but imported rice reappeared sooner than later because another government policy liberalized rice imports in 1997. This indeed led to another drop in local rice production.

However, Nigeria has produced more rice in the last five years than any other time since the return of democracy in 1999. Data from the United Nation Food and Agricultural Organization (2019) shows that Nigeria maintained top spot among rice producers in Africa between 2014 – 2019. Between 2014 -2016, Nigeria's rice paddy production figures constantly rose from 6.0 to 6.2 and to 7.5 million metric tons (mmt). In 2017, Nigeria production figure fell to 6.61 mmt but increased in 2018 to 6.81mmt. In 2019, it dropped to 5.1 mmt. Historically, rice paddy production was 3.3mmt. during Obasanjo's regime; 4.1 mmt during Late Musa Ya'Adua; 5.4 mmt during Goodluck Jonathan; and 7 mmt under president Mohammed Buhari's regime. That the growth in rice paddy production from 325.000 tons in 1969 to 5.1 mmt in 2019 is at an average of 8.76% (Mojeed, 2020)

In a related report IRRI (2013) stated that area for rice production increased from 1.8million ha in 1995 to about 2.7 million ha in 2006, but dropped back to 1.8 million ha in 2010. Also production increased from 2.92 million tons in 1995 to 4.18 million tones of paddy rice in 2008 but went down to about 3.23 million tons in 2010. That rice yield across all ecosystems over the last 20 years were between 1.3 t/ha and 1.9t/ha.

In a report titled 'Nigeria milled rice production over 20 years Mba (2021) stated succinctly that rice production in Nigeria has surpassed 5 million tones yearly since 2016. The author regretted that only 57% of the metric tons of rice consumed in Nigeria each year is produced locally despite records of increased in rice yield since 2016. That this worrisome scenario has culminated into a 3 million metric tons rice deficit that is secretly and criminally imported or smuggled into the country despite the government ban on rice imports which has been in effect since 2019. The author wondered why Nigeria is yet to achieve self-sufficiency in rice production when in 2020, She became the largest producer of rice in Africa and the 14th largest in the world. Worst still is the fact that illegal rice smuggling business is still thriving in spite of many deterrents.

Many authors have attributed Nigeria's self-insufficiency status in rice production which is characterized inter-alia by high level of rice importation and smuggling, scarcity of rice in the market and above all the unprecedented rise in the price of rice to many factors. Among such factors are; government weak and disjointed agricultural programs; corruption; insincerity in the implementation of agricultural programmes; poor agricultural extension services; and the impact of climate changes.

United Nations Framework Convention on Climate Change (UNFCCC, 1992) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time period.

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According to the US Geological survey as cited in IPCC (2014), climate change refers to the increasing changes in the measures of climate over a long period of time including precipitation, temperature and wind patterns. These changes in climate certainly have effects on the environment and other living things (animals and plants) which depend on the environment for survival and comfort. These said effects which could be positive or negative are known as climate change impacts.

Climate change impacts are the consequences of climate change which are both expected and realized for natural and human systems. It therefore means exposure and sensitivity to climate risks results in the climate impact on the system in question.

Many researchers have studied the impact of climate change on agriculture in general and on rice production to be more specific. Saud et.al (2022) researched on "Comprehensive Impacts of Climate Change on Rice Production and Adaptive Strategies in China" while Abbas and Mayo (2020) studied the "Impact of Temperature and Rainfall on Rice Production in Punjah, Pakistan". Also Pickson and Boateng (2022) researched on the "Impact of Climate Change and Smallholder Farmers Adaptive Capacity on Rice Production in Chengdu China, Macro-Micro Analysis" whereas Stueker, Tigchelaar and Kantar (2018) studied "Climate Variability Impacts on Rice Production in the Philippines." Additionally, Sharma et al (2022) researched on "The Impact of Recent Climate Change on Corn, Rice and Wheat in Southeastern USA" while Naylor, Rattisti, Vimonth , Falcon and Burke (2007) researched on "Risk Assessment of Climate Variability and Climate Change for Indonesian Rice Agriculture."

Understanding the impacts of climate change on rice production will inter-alia enable farmers to reduce activities and practices that will directly or indirectly cause or speed up changes in climate. It will also help farmers to plan on how to adopt copping strategies that will reduce the negative effects of climate change on humans and agriculture. It is against the background that none of the studies reviewed above was carried out in Northern Cross River State Nigeria that this study titled "The impact of climate change on rice production in Northern Cross River State" was conceived and executed. Specifically the study was designed to answer and as well test the following research questions and hypothesis respectively.

R.Q.I. What are the climate change indicators that rice production system is exposed to in Northern Cross River State, Nigeria ?
R.Q.II. What impacts have climate change on rice production in Northern Cross River State, Nigeria?

Ho: Years of experience in rice farming has no significant influence on the responses of farmers on impacts of climate change on rice production.

II. METHODOLOGY

This study adopted a descriptive survey research design and was carried out in Northern Cross River State, Nigeria. A sample of 350 rice farmers drawn (using random sampling technique) from a population of all rice farmers in the five Local Government Areas (i.e 70 rice farmers per Local Government Area) that make Northern Cross River State responded to a structured questionnaire which contain 45 items out of which 12 items were on personal or demographic characteristics of respondents and agronomic practices adopted in their rice farms. Prior to administration of the questionnaire by trained research assistants, its draft was validated by 3 experts drawn from the Department of Agricultural Education, University of Nigeria Nsukka .Data generated for this study was analyzed using mean and standard deviation to answer research questions, and ANOVA to test hypothesis at .05 level of significance since the hypothesis had more than two groups

III. RESULTS

The results of the study were obtained from the research questions and hypothesis answered and tested respectively after data analyses

Research Question One: What are the various climate change indicators that rice production system is exposed to in Northern Cross River State?

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S/N	various climate change indicators that rice production system is exposed to	X	S.D	RMKs
13	Increased temperature during the cultivation period	3.04	0.94	A
14	Very low amount of rainfall during the cultivation period	2.68	1.01	A
15	Late commencement of rainfall	2.92	0.80	A
16	High solar radiation or sun rays during the cultivation period	2.58	1.04	A
17	Excessive rainfall during rice production season	2.82	0.98	A
18	Early commencement of rainfall	2.74	0.87	A
19	Very short rainfall period	2.78	0.99	A
20	High amount of water in the air during rice production season	2.92	0.98	A
21	Early cessation of rain (Rainfall stopping very early)	2.86	1.02	A
22	Flood or water submerging rice farm for a long period of time	2.78	0.97	A
23	Late cessation of rain (Rainfall stopping very late)	2.72	0.85	A
24	Stoppage of rainfall at critical stage in rice production	2.64	1.01	A
25	Early commencement of harmattan	2.76	0.95	A
26	Heavy rain followed by intensive sun on the same day.	2.10	0.92	D
CLUSTER		2.73	.43	A

Table 1: mean ratings of responses on various climate change indicators that rice production system is exposed to in Northern Cross River State

Source: field survey /Data analysis

Keys: X = Mean, S.D. = Standard Deviation, Rmks = Remarks, A = Agreed, D = Disagreed

Table I above presents mean rating of respondents on various climate change indicators that rice production system is exposed to in Northern Cross River state. The analysis revealed that thirteen out of fourteen items had their mean ratings ranged from 2.58 to 3.04 which is above 2.50 branch mark on a four point rating scale. This indicates that respondents agreed that the thirteen items were various climate change indicators that rice production system is exposed to in the study area. Also a cluster mean of 2.73 which is above 2.50 cut-off point implies that all the fourteen items are climate change indicators that rice production system is variously exposed to in the study area. The findings also showed that the standard deviation of the fourteen items ranged from 0.80 to 1.04. This implies that the responses were tightly clustered around the mean and thus shows little variability. This is an indication of homogeneity in agreement and hence pointing to the fact that greater number of the respondents agreed that all the items were climate change indicators that rice production system is exposed to in Northern Cross River state.

Research Question Two: What impacts have climate change on rice production in the study area?

S/N	Impact of climate change on rice production	X	S.D	RMKs
27	Shortage of rainfall reduces rice yield.	3.58	0.70	A
28	High temperature leads to the death of rice plants.	3.28	0.78	A
29	Cool weather causes poor rice germination.	2.84	0.90	A
30	Shortage of rainfall kills rice plant	3.32	0.79	A
31	Very high temperature affect flowering of rice plant	2.92	1.04	A
32	Very high temperature reduces the weight of rice grain	2.90	0.99	A
33	Very high temperature reduces the size of rice grain	2.80	1.08	A
34	Flood (excess water) washes away or submerges rice farm	3.82	0.81	A
35	With flood, water will wash away rice seeds yet to germinate.	3.64	0.63	A
36	Rebroadcasting of rice after incidence of flood will increase the cost of production.	3.12	1.07	A
37	Late commencement of rainfall delays the cultivation of rice	3.50	0.67	A
38	Too much water washes away fertilizer that is applied thereby reducing growth & yield of rice	3.34	0.82	A
39	Flood damages farmers' infrastructures that support rice production.	3.36	0.77	A
40	Too much water brings soil particles from upper part of the farm to cover rice seeds and seedlings.	3.36	0.80	A
41	Prolong shortage of rain during the reproductive stage of rice leads to rice failure.	3.40	0.66	A
42	High temperature decreases the yield of dry season rice.	2.92	0.91	A
43	High temperature causes poorly filled grains (Shafts)	3.20	0.63	A
44	High temperature shortens rice growth period	3.18	0.77	A
45	High night temperature decreases rice yield.	2.36	0.93	D
CLUSTER		3.20	0.29	A

Table 2: mean ratings of response on impact of climate change on rice production in Northern Cross River State.

Source: field survey /Data analysis

Keys: X = Mean, S.D. = Standard Deviation, Rmks = Remarks, A = Agreed, D = Disagreed

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Table II above presents mean ratings of respondents on impact of climate change on rice production in Northern Cross River State. The analysis revealed that eighteen out of nineteen items had their mean ratings ranged from 2.80 to 3.82 which is above 2.50 branch mark on a four point rating scale. This indicates that respondents agreed that eighteen items were various impacts of climate change on rice production in the study area. Also a cluster mean of 3.20 which is above 2.50 cut-off point implies that all the nineteen items are impact of climate change on rice production in the study area. The findings also showed that the standard deviation of the nineteen items ranged from 0.63 to 1.08. This implies that the responses were tightly clustered around the mean and thus shows little variability. This is an indication of homogeneity in agreement and hence pointing to the fact that greater number of the respondents agreed that all the eighteen items were impact of climate change on rice output in the study area.

Hypothesis One: Years of experience in rice farming has no significant influence on the responses of farmers on impact of climate change on rice production in the study area.

The data for testing hypothesis one is presented on table 3.

Source of difference	Sum of square	Df	Mean square	F ratio	p-Val.	Rmks
Between groups	2.825	3	.942	12.363	0.000	N.S
Willing groups	26.353	346	.076			
Total	29.177	349				

Table 3: Analysis of variance (ANOVA) statistics on mean ratings of responses of rice farmers by years of experience in rice farming on impact of climate change on rice production in Northern Cross River State. N1 = 56, N2 =140, N3 =98, N4 =56.

Source: field survey /Data analysis

Table III presents summary of analysis of variance statistic for the responses of rice farmers by years of rice farming experience on impact of climate change on rice production in Northern Cross River State. From the table, the F-ratio of 12.363 with a p-value of .000 at 3 and 346 degrees of freedom is greater than 0.05. This indicates that there is no significant difference in the mean responses of the four groups of respondents on the basis of years of rice farming experience(1-10; 11-20; 21-30 ; and above 30 years respectively) on impact of climate change on rice production in Northern Cross River State. Thus, the null hypothesis is upheld. This implies that respondents on the basis of years of rice farming experience do not differ significantly in their opinion on impact of climate change on rice production in the study area.

IV. FINDINGS

The following findings emerged from the study based on the research questions answered and the hypothesis tested.

- Results on the various climate change indicators that rice production is exposed to in Northern Cross River State showed that respondents agreed that rice production in the study area is exposed to various climate change indicators. Out of the 14 items (indicators) listed, the only indicator not accepted by the respondents was "heavy rain followed by intensive sun on the same day".
- Results on the impacts of climate change on rice production in Northern Cross River State showed that respondents agreed that climate change has impacts on rice production. Out of 19 items on suggested impacts of climate change on rice production, the only item rejected by respondents was that high night temperature decreases rice yield.
- The result of hypothesis one showed a non-significant difference in the mean responses of rice farmers by years of rice farming experience on impact of climate change on rice production. This showed that years of rice farming experience has no influence on farmer responses as they were unanimous in their opinion on impact of climate change on rice production.

V. DISCUSSION OF RESULTS

The findings of the study are discussed in sections in line with the research questions/hypothesis for the study viz:

- What are the climate change indicators that rice production is exposed to in Northern Cross River State, Nigeria ?
- What impacts have climate change on rice production in Northern Cross River State, Nigeria?
- Years of experience in rice farming have no significant influence on the responses of farmers on impacts of climate change on rice production.

A. Climate change indicators that rice production is exposed to in Northern Cross River State

The findings as presented in table 1 showed that respondents agreed that rice production in the study area is exposed to various climate change indicators. These findings are in consonance with the conclusion of United State Department of Agriculture (2020) that climate change indicators are measurements or calculations that tell the status of a system of interest. Climate change indicators provide information about the magnitude, timescale, and effects of environmental changes relative to historical information. These indicators may be derived from changes in direct measurement of temperature, precipitation, heat waves, nighttime air temperature, soil moisture, humidity, weed range and infestation intensity, crop pathogens, insect infestation in crops among others. These findings are in line with the situation in Uganda which Lumala (2008) reported that in the usually wet month of October, people were

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already feeling the scorching heat at 8.00am with the sun blazing over Bukono village in Iganga district in the east of Uganda. Also that young maize shoots were withering at an alarming rate due to lack of rainfall. Also in Nepal, Gurung and Bhandari (2008) reported that climate change is already being felt and its effects are expected to continue and to increase. The country's glaciers are retreating and the discharges of snow-fed rivers have fluctuated with rising temperature having impact on and making agriculture more difficult. The authors maintained that landslides, erratic rainfall patterns and floods were major hazards experienced and were easily linked to changing climate. Little wonder Awuor (2008) lamented that many parts of Kenya were already experiencing unpredictable weather with more frequent droughts, floods and strong winds particularly at the coast.

B. Impacts of climate change on rice production in Northern Cross River State.

The findings as presented in table 1I showed that respondents agreed that climate change has impacts on rice production in the study area .These findings are in agreement Abbas and Mayo (2020) that maximum temperatures negatively affects rice plant resulting in decrease in the number of plants at replantation stage. The positive impact of minimum temperature on rice production is growth of plant, which affect the rice crop at replantation state during vegetative phase. The number of tillers and rice plant diet increase with the positive impact of rainfall at tillering stage. Maximum temperature has negative impact on rice crop at tillering and stem elongation stages while rainfall has negative impact on rice plant at heading and flowering stages. Substantial reduction in rice production is observed due to damage of reproductive cells at heading and flowering stages during the reproductive phase. These findings are also in line with the position of Pickson and Boateng (2022) that mean rain fall and temperature induce rice production positively in the long and short run. While temperature variability insignificantly impacts rice production in the long run, it plays a substantial role in the short run.

C. Years of experience in rice farming has no significant influence on the responses of farmers on impacts of climate change on rice production

Test of hypothesis as presented in table III shows that respondents were unanimous in their opinion on impact of climate change on rice production. This findings agrees with the position of Ayang (2016) who lamented that the effects of climate change are generally felt by all and sundry (human race, plants, animals and the environment) but farmers are said to have the worst of it because their crops; animals; agricultural resources (land/soil, streams/river, forest e.t.c); production practices and processes such as tillage, planting, harvesting, processing, storage and others; and above all themselves are all affected by the negative impacts of climate change.

VI. CONCLUSION

Based on the findings of the study, the following conclusions were drawn:

- Rice production in Northern Cross River State is exposed to various climate change manifestations or indicators.
- Climate change has a lot of impact on rice production in the study area
- Years of rice farming experience have no significant influence on farmer responses on impact of climate change on rice production

VII. IMPLICATION OF THE FINDINGS

The findings of this study have the following far reaching educational implications.

There is an urgent need for government and NGOs to develop and implement climate change mitigation and adaptation programme for rice farmers. This will enable rice farmers who are already aware of: many climate change indicators and the impact of climate change on rice production to learn and as well adjust their farming practices in other to cushion effects of climate change and thereby improve the production of rice.

The identified climate change indicators that rice production is exposed to will provide a guide on the intensity and frequency of climatic extremes. Stakeholders in Agriculture or rice production will use the knowledge of such climatic extremes to plan and implement a programme that will mitigate the intensity and frequency of such indictors. It will also guide them in planning and implementing adaptation measures with a view to boost rice production.

The impact of climate change on rice production as determined in the study will point out the likeliness of rice farmers in the study area to adopt an intervention programme aimed at reducing the said impact of climate change. Succinctly put, rice farmers will be willing to work with extension agents to check impact of climate change on rice production since they are aware or made to understand how rice productivity is affected by climate change.

Rice farmers will be guided by the indicators and impacts of climate change in taking major decisions on agronomic practices that will help mitigate the impact of climate change on rice production. It will also guide them in deciding adaptation measures that will equally reduce the impact of climate change on rice production.

VIII. RECOMMENDATIONS

On the basis of the findings, discussion and conclusion of the study, the following recommendations were made:

Experts developing agricultural extension programmes on climate change should involve rice farmers who are already aware of climate change indicators for meaningful contribution and effective participation in the programme development process.

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Agricultural extension agents should identify rice farmers who are already aware of the impact of climate change on rice production for agricultural input supply and other palliatives including subsidies. This will encourage such farmers to continue or expand the cultivation of rice irrespective of challenges posed by climate change.

Government and NGOs should make budgetary provisions for incentives to be provided to rice farmers to cushion the impact of climate change on rice production.

Incentives that will enhance the adoption of strategies for climate change mitigation and adaptation by rice farmers should be provided by government and NGOs. This will not only increase rice production but also make such production sustainable.

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