



## Perceptions of climate change and variability, impacts and adaptation strategies by rice farmers in south east Nigeria

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### Abstract

This study was designed to identify level of awareness/knowledge of rice farmers in South-eastern Nigeria about climate-change; identify adverse effects of climate-variability and change on rice production and determine adaptation strategies used by small holder rice farmers within study area. Multistage purposive and stratified sampling technique was used for the sample selection. Information from 360 respondents was got using Rapid Rural Appraisal (RRA), Focus Group Discussions (FGD), and actual survey with questionnaires. Results showed that the rice farmers were aware of weather changes with grave effects on their rice farms. They reported changes in rainfall regime, intense sunshine, high temperature etc. Of special interest among the adaptation strategies by farmers are the use of inorganic fertilizers, improved rice varieties, cultivation of early maturing varieties, and proper preservation of rice seeds. This study recommends urgent measures to improve resilience of smallholder farmers in rural communities to enable them better adapt to climate-change.

**Key words:** Improve rice varieties, Inorganic fertilizers, Rice production, Weather changes

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## Introduction

Over the past century, global average surface temperature has increased approximately by 0.6°C and this has actually affected both plants and animals differently. The IPCC's Fourth Assessment (AR4) made clear that Africa is a vulnerability hotspot for climate change. (IPCC, 2001) and is projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003), particularly because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. As the people of Africa strive to overcome poverty and advance economic growth, this phenomenon threatens to deepen vulnerabilities, erode hard-won gains and seriously undermine prospects for development (Zoellick, 2009). In Nigeria, climate change affects its economies because its economic activities are natural resource sensitive such as agricultural activities leading to significant reductions in agricultural productivity (Akinbobola *et al.*, 2015).

Rice is one of the food security crops in the continent of Africa, especially Nigeria, but its production is not growing fast enough in relation to the available potentials in the country. Nigeria demand about 5.0 million metric tonnes of rice annually, but about 3.2 million metric tonnes are produced locally running a deficit of about 1.8 million tonnes (ATA, 2012). Decreases in crop production that may be traceable to climate change have been generally observed.

Rice (*Oryza sativa* L.) production is greatly dependent on environmental factors provided by nature and the optimum combination of these factors, plus production inputs determines yield. Rainfall character-

istics (intensity and duration), relative humidity and temperature constitute some environmental factors that affect rice yield and its variability. Climate change through extreme temperatures, frequent flooding, drought and increased salinity of water supply used for irrigation in rice fields also constitute factors that affect agricultural productivity (Manneh *et al.*, 2007). Drastic changes in rainfall patterns and rise in temperatures introduces unfavourable growing conditions into the cropping calendars thereby modifying growing seasons which could subsequently reduce crop productivity.

In Sub-Saharan Africa, according to Komba and Muchapondwa (2015) climate change is set to hit the agricultural sector the most severely and cause suffering, particularly for smallholder farmers. To cushion themselves against potential welfare losses, smallholder farmers need to recognize the changes already taking place in their climate and undertake appropriate investments in adaptation. Several studies conducted to examine perceptions of farmers on climate change have shown that farmers had different perceptions on climate change.

In a study of farmers in Southeast Nigeria, majority of the farmers did not agree that farming contributes to climate change, but were aware of climate change and its effects on agriculture (Enete *et al.*, 2011). On the other hand Uzor *et al.* (2015) reported that 40.6% of their respondents in Imo state Nigeria know a little about Climate change while a significant proportion of 21.7% are clueless. Adebayo *et al.* (2012) assessed the awareness, vulnerability and adaptation of farmers to climate change in Adamawa state Nigeria. Majority of the farmers in the state are

aware of climate change and submitted that climate change has affected their farming activities in recent years. They identified climate change effects to included reduced crop yield, shortage of water and biomass for animals due to low rainfall and frequent dry spells. Similarly high temperature causes wilting of crops and diseases while excessive rainfall leads to destruction of farmlands and properties by flooding.

Okonya *et al.* (2013) posit that there is limited knowledge on whether farmers perceive climate change and how they are responding to the effects of a changing climate. Most studies assessing the potential effects of climate change on African agriculture are regional or national and yet adaptation is place-based and needs the use of place-specific strategies (Deressa *et al.*, 2011). It is therefore important to note that local perceptions cannot be estimated by models and the need to document how the lives of the local people are affected by the recent changes in climate (Okonya *et al.*, 2013) hence this work.

The study was designed to: a) examine rice farmers' perception and knowledge of climate-change in south-eastern Nigeria; b) identify adverse effects of climate-change on rice production and c) determine adaptation strategies used by smallholder rice farmers within study area.

## Methodology

### Study area

The study area comprised of two states, Ebonyi and Enugu States in south eastern Nigeria (Figs. 1-3). South eastern Nigeria is located within longitudes 5°30' and 9°30' E and latitudes 4° 30' and 7° 00' N, occupying a land area of about 75,488 km<sup>2</sup>. The population pressure is the most important problem of rural development in this region,

recognisable from a broad spectrum of livelihood activities such as intensive agriculture, engagement in non-farm activities and migration into urban cities. All the people who are engaged in both intensive agriculture and non-farm occupation for their livelihood activities constitute the population for the study.



**Figure 1.** Map of Nigeria showing the states under Study

### Data collection

A representative sample of 360 farmers (75% male and 25% Female) randomly selected constituted the respondents for the study. Multistage purposive and stratified sampling technique was used for the sample selection based on a sampling frame of contact farmers of the Agricultural Development Programme (ADPs) of study States.

Rapid Rural Appraisal (RRA) and Focus Group Discussions (FGD) were used to establish farmers/stakeholders' awareness and knowledge of climate change, its effects on rice production, including adaptation and resilience strategies. Actual survey was done using questionnaires structured in line with the specific objectives of the study. The instrument was tested for reliability and also validated. Then one-day

training was conducted for the Field Assistants (16) and Research Assistants (8) to familiarize them with the instruments for data collection prior to actual survey.

The data were analysed with descriptive statistics, percentage distribution and bar charts (Adebayo *et al.*, 2012; Okonya *et al.*, 2013; Uzor *et al.*, 2015)

**Results and discussion**

***Farmer awareness of climate change and variability***

All the rice farmers (100%) in this study were aware of changes in weather (climate change) in relation to the effects it may be having on their rice farms. They reported specific knowledge of climate change in terms of changes in rainfall regime, intense sunshine, high temperature and flooding (Fig. 4). Most of the farmers (84.4%) experienced major variations in seasonal changes, while large numbers of them (73.4%) reported massive floods in their communities. Majority (98.2%) indicated excessive temperature increase. About eighty six percent (86.2%) of the rice farmers experienced variation in life cycle of rice plants. Others experienced reduction in yield of rice due to over flooding (70.7%) and excessive temperature (92.5%), increase in pest and diseases infestation (92.8%) and a sudden and increased loss of rice farm land (71.6%). This increased their awareness of impeding food insecurity and hunger (95.2%).

Uzor *et al.* (2015) observed that 40.6% of rural farmers in Imo State Nigeria knew a little about climate change, 31.1 and 6.6% knew and knew a lot about climate change respectively. Unfortunately a significant proportion of the farmers (21.7%) does not know anything about climate change. On the other hand Oluwatusin (2014) observed that that most sampled cocoa farmers in Ondo State Nigeria noticed climate change in their area. About 75% perceived increase in temperature



Figure 2. Map of Ebonyi State Nigeria

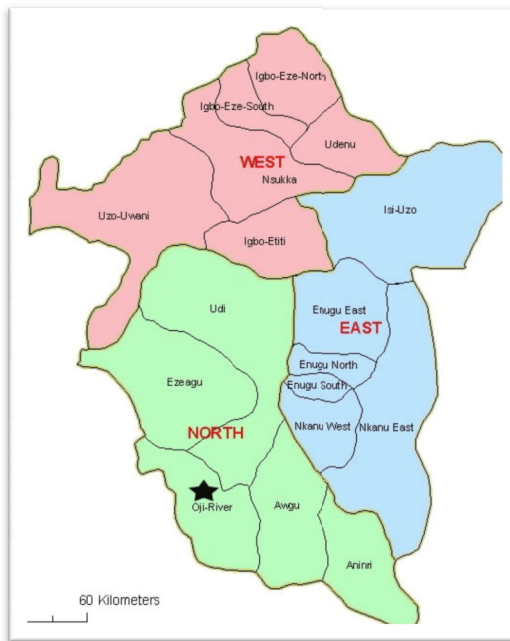
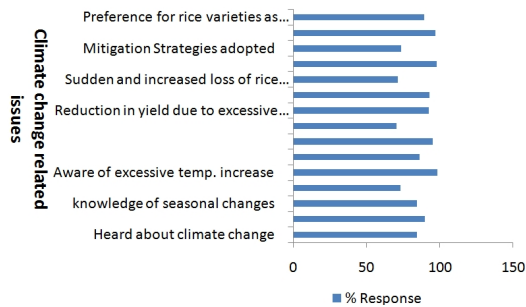


Figure 3. Map of Enugu State Nigeria

around their area for over the last 5 years. Also 81.25% of them noticed change in climatic condition as increase in rainfall while 150 farmers constituting about 93.75 % perceived change in the timing of the rain. Only a 3.12% of them did not detect any change in the condition of climate in the study area.



**Figure 4.** Percentage perception/awareness of small-holder rice farmers in South-eastern Nigeria about climate change related issues.

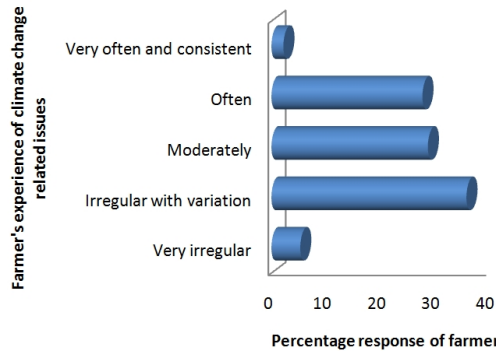
Reporting a farm level study in Bangladesh, Uddin *et al.* (2014) showed that some 88% of respondents indicated that, within the last 20 years, they have, experienced climatic change. The farmers all agreed that they had experienced increases in temperature, droughts, flooding, cyclones, and soil salinity. Across all events, at least 80% or more reported having experienced climatic shifts which are likely to have a negative impact on agricultural activity. Local people’s perception of climate change, its impact and adaptation practices in Norway, revealed that, more than 80 percent have perceived increased temperature and expressed low amount snowfall in High mountain and rainfall in Mid mountain and Tarai region over the last five years. Low amount of snow fall in the Himalayan region affected the Nomad groups due to low grass available to feed their livestock.

Oluwatusin (2014) observed that perception of climate change is directly proportional to the age of the farmers and that older respondents are more efficient in perceiving climate change than the younger respondents. Educational level of farmers also plays a good role in perceiving change in climatic conditions. Benedicta *et al.* (2010) confirms that the level of education, Among other factors like gender, age, soil fertility, farm size, farming experience, land tenure, access to extension services and credit, all influence farmers perception and adaptation in Ghana.

It is important to note that climate change refers to any change in climate over time whether due to natural variability or as a result of human activity (IPCC, 2007). It could also be defined as any significant change in measures of climate lasting for an extended period. This include changes in average global temperature as well as changes in how frequently regions experience heat, droughts storms floods and other extreme events (CCIR, 2005). The Intergovernmental Panel on Climate Change (IPCC, 2007) forecasts that developing countries will continue to be affected by extreme weather variability such as temperature, severe water shortage, and flood-inducing rainfall events during the coming decades. Weather variability and sea-level rise are the most pressing predicted consequences of climate change with a 0.6 °C global temperature change, 2% to 3% precipitation increase of the tropical latitudes and 3% precipitation decrease in subtropical areas within the 20<sup>th</sup> century. Scenarios predict global temperature could increase between 1.4°C and 5.8°C by the end of the 21st century (IPCC, 2001).

**Perceived impacts of climate change and variability**

Results from the experimental sampling (Fig. 5) indicate that majority of the rice farmers experienced climate change related problems on their rice farms, either often (27.8%) or moderately (28.8%). About 35.9% of the farmers indicated that climate change induced problems on rice production were irregular with variations. Very few farmers (2.2%) indicated that climate change effects were very often and consistent on their farms.



**Figure 5.** Farmers experience of climate change and related issues in south eastern Nigeria

Table 1 shows climate-related problems affecting rice production in south eastern Nigeria. Responding to the questionnaire (requiring answers like no effect (1); little effect (2), no idea (3), medium effect (4) great effect (5)),rice farmers indicated variation in patterns of adverse effects of climate change on rice production. The highest severe climate change effects were experienced under severe hot temperature ( $\bar{X} = 4.3$ ), late onset of rains ( $\bar{X} = 3.9$ ) and variability in weather condition ( $\bar{X} = 3.8$ ). Acid rain had a low coefficient of mean deviation ( $\bar{X} = 2.3$ ) probably because its effect on rice production is difficult to estimate quantitatively in the farm by smallholder rice farmers.

**Table 1.** Climate-related problems affecting rice production in south eastern Nigeria

| Climate related problems                             | Mean (Max = 5) | Std. Deviation |
|--|----------------|----------------|
| Climate variability                                  | 3.8            | 1.0            |
| Absence of forest/deforestation                      | 3.3            | 1.1            |
| Low rainfall intensity                               | 3.7            | 0.9            |
| Acid rain  | 2.3            | 1.4            |
| Biodiversity decline                                 | 2.9            | 1.1            |
| Increased water stress                               | 3.4            | 1.2            |
| Decrease in length of rice production                | 3.3            | 1.1            |
| Decrease in yield of rain-fed paddy                  | 3.6            | 1.1            |
| Reduction in resilience of agro-ecosystem by drought | 3.5            | 1.0            |
| Unfriendly flooding                                  | 3.3            | 1.4            |
| Land degradation                                     | 3.5            | 1.3            |
| Loss of arable soil surface                          | 3.3            | 1.1            |
| Unpredictable loss of water                          | 3.6            | 1.1            |
| Severe hot temperature                               | 4.3            | 2.8            |
| Late onset of rains                                  | 3.9            | 1.1            |
| Erosion problem                                      | 3.5            | 1.2            |
| Distortion of rice growth                            | 3.5            | 1.1            |
| Inadequate tillering                                 | 3.3            | 1.1            |
| Destruction of paddy fields by rain                  | 3.4            | 1.2            |
| Sludge in paddy field due to heavy wind              | 3.1            | 1.2            |
| Abnormal changes in processed rice                   | 2.8            | 1.3            |
| Sour taste of processed rice                         | 2.5            | 1.4            |
| Reduced market of processed rice                     | 2.9            | 1.4            |

Source: Field Survey (2011)

There are diverse and mixed views about the indicators of climate change across and within communities in Africa, despite the evidence of a general awareness (Ejembi and Alfa, 2012). In Wenchi, Ghana, farmers listed the following observed changes: Reduction in soil fertility levels, reduction in yields of major staples such as yam and maize disappearance of cocoa as a major cash crop, disappearance of the forest and wildlife, hanges in rainfall

pattern, proliferation of disease and insect pests proliferation of obnoxious weeds, eg. spear grass. Farmers' own responses to these changes included planting different (early maturing) crops, planting earlier and using more agro-chemicals (Paul *et al.*, 2008).

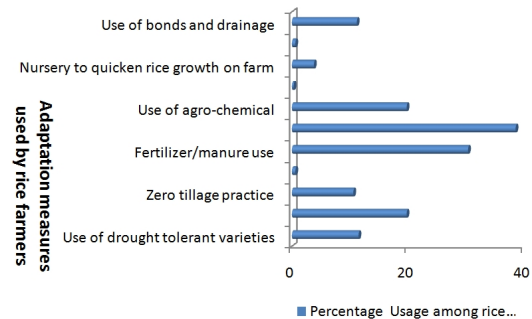
Empirical results (Ajetomobi *et al.*, 2010) show that climate change is significant to rice agriculture in Nigeria. They established that net revenue per hectare was sensitive to marginal change in climate variables (temperature and precipitation). Sushant (2013) reported that production of rice will be undermined as temperature increases in rice-growing areas with continued climate change. High temperatures decrease rice yield in tropical climate areas (FAO, 2002). Evidence from research also indicates that the net impact of projected temperature increases is to slow the growth of rice. Daily minimum temperature increases, or hotter nights leads to a drop in rice yields (Peng *et al.*, 2004).

**Perceived adaptation strategies and constraints**

In this study strategies employed by rice farmers in south eastern Nigeria in adapting to climate change include: mulching for water conservation especially during nursery preparation, preparation of nursery prior to planting, use of zero tillage, proper site selection, use of fertilizer and agrochemicals, early planting and construction of bonds and drainage to conserve water. The percentage usage of these strategies (technologies) were however low, with only early planting and use of fertilizers recording 38.6% and 30.4%, respectively (Fig. 6). The rice farmers perceived most of the adaptation strategies as significant in

overcoming the effect of climate change in rice production.

Prantilla and Laureto (2013) cited a study by John J. Carroll Institute on Church and Social Issues and reported that rice farmers from Isabela and Iloilo Philippines used the following technologies to cope with climate change effects in their farms: water pump and shallow tube for irrigation, change rice varieties, adjust planting spacing, perform synchronous planting, plant multi-purpose tree species, change planting calendar, practice contour and organic farming, borrow from traders and neighbours, engage in other agricultural production, seek off-farm jobs, and sell assets. Similarly rice farmers in Camarines Philippines have resorted to the use of high-yielding and/or early maturing varieties, changing planting dates, diversifying crops, and taking non-farm jobs to cope with the effects of rainfall variability and extremes (Cuesta and Ranola, 2009).



**Figure 6.** Adaptation measures used by rice farmers to overcome climate change effects in rice production in south eastern Nigeria

Smallholder rice farmers' perception of constraints to adaptation to climate change is shown in Table 2. The major severe constraints based on high mean deviation score include: no subsidies on necessary farm inputs and lack of credit facilities

( $\bar{X}$  = 4.3), lack of climate change information ( $\bar{X}$  = 4.2), lack of access to improved rice varieties, late supply of inputs, fertilizers and agrochemicals and limited knowledge of adaptation measures available ( $\bar{X}$  = 4.4), irregularities of extension services and poor government policy on climate change ( $\bar{X}$  = 4.0). The least constraining factor is socio-economic and cultural issues ( $\bar{X}$  = 3.0).

**Table 2.** Constraints to adaptation and mitigation to climate change in south eastern Nigeria

| Constraint Issues  | Mean | Std. Deviation |
|--|------|----------------|
| Lack of information  | 4.2  | 1.0            |
| Ineffectiveness of indigenous strategies                               | 3.7  | 1.1            |
| Irregularity of extension services                                     | 4.0  | 1.0            |
| No subsidies on necessary farm inputs                                  | 4.3  | 0.8            |
| Lack of credit facilities  | 4.3  | 0.8            |
| Lack of access to improved rice varieties                              | 4.1  | 1.0            |
| Late supply of inputs, fertilizers and other agro-chemicals            | 4.1  | 0.9            |
| Absence of water management techniques                                 | 3.8  | 1.2            |
| Inability of farmers to access available information on climate change | 3.9  | 1.1            |
| Poor land management techniques  | 3.8  | 1.1            |
| Incomprehensive information on climate change among farmers            | 3.8  | 1.2            |
| Socio-economic and cultural issues                                     | 3.0  | 1.2            |
| Traditional values among rice farmers                                  | 3.1  | 1.3            |
| Poor government policy on climate change                               | 4.0  | 1.0            |
| Low institutional support  | 3.9  | 1.0            |
| Limited knowledge on adaptation measures.                              | 4.1  | 1.0            |

Source: Field Survey (2011)

The present result confirms the use of inorganic fertilizers, use of improved rice varieties, cultivation of early maturing va-

rieties, and proper preservation of rice seeds as important adaptation measures. It corroborates the results of Ajetomobi *et al.* (2010) who identified improved and early maturing varieties as good adaptation measures to overcome the effects of climate change on rice production in Nigeria. While analyzing farmers' perceptions of climate change, governance and adaptation constraints in the Niger Delta region of Nigeria, Nzeadibe *et al.* (2011) share similar opinion and confirmed the importance of these factors. They pointed out that the factors responsible for hindering adaptation are inadequate information, limited awareness and knowledge about adaptation methods, and poor government attention to the phenomenon of climate change. Among the local people of Norway, Tiwari *et al.* (2010) observed that poverty and lack of any government formulated policies and programs have undermined the adaptation strategies in this region.

On the other hand only socio-economic and cultural issues were regarded by the farmers to be of no serious constraint to adaptation and mitigation to climate change in rice production. This meant that farmers did not see anything wrong in their norms and value orientation systems. This underscores the need for more extension services by the Agriculture Development Programs (ADP) to emphasise proper understanding of the socio-economic and cultural issues of the farmers as preconditions for efficient extension service delivery, including climate change and rice production.

### Conclusion

Changes in climate were well perceived by rice farmers in the study communities. They reported specific knowledge of climate change in terms of changes in rainfall



regime, intense sunshine, high temperature, frequent pest and diseases outbreak/infestation and reduced yield in their rice farms. High temperature was indicted for causing high heat, reduction in germination and drying of seedlings established in the nursery, while humidity was low, sometimes slowing seed germination.

The adopted strategies by farmers included among others, use of fertilizer and agrochemicals, early planting and construction of bonds cum drainage to conserve water. The percentage usage of these strategies (technologies) were however low. Urgent measures are recommended to be undertaken to improve the resilience of smallholder farmers in rural communities. This will enable them better adapt to climate change. Conscious effort is required to increase the awareness of smallholder farmers and policy makers on climate change. There is need to document climate risks, identify specific problems in relation to rice production, document traditional adaptation measures where available within the study area. The identified constraints constitute areas for intervention in mitigation to effects of climate change on rice production.

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