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How Does Climate Change Affect Rice Farming?

A Ricardian study from Nigeria

Abstract

This CEEPA study from Nigeria assesses the impact of climate change on rice cultivation. The Nigerian agricultural sector is particularly vulnerable to climate change, which is already having a significant impact on the country. The study was the work of a team from the Ladoke Akintola University of Technology. It was based on a survey of 1,200 rice farmers from 20 rice-producing states in Nigeria.

Most significantly, the study found that climate change has a significant impact on rice agriculture. It shows that both net revenue and land rent per hectare are negatively affected when temperature rises and precipitation falls. The results clearly demonstrate that irrigation can help farmers to adapt to climate change. It therefore recommends that investments should be made to improve Nigeria's irrigation systems both in terms of facilities and manpower.



Rice cultivation in Nigeria

A summary of CEEPA Discussion Paper No. 54: 'Impact Of Climate Change On Rice Agriculture In Nigeria' by Joshua Olusegun Ajetomobi and Abiodun Ajiboye, Department of Agricultural Economics, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Contact

Joshua Olusegun Ajetomobi

Email: jsegun2002@yahoo.com

Report Summary

As is the case in many other developing countries, Nigeria faces an enourmous challenge from climate change and global warming. Already, temperature increases of about 0.2°C - 0.3°C per decade have been observed in the country. There is also evidence of an increase in rainfall in the country's coastal areas and a decline in rainfall in Nigeria's semi-arid regions.

The increasing rainfall along the coast has been shown to be responsible for devastating flooding, while climate changes in the semi-arid regions have resulted in drought and desertification. Climate change has also been linked to a reduction of water levels in some rivers in Northern Nigeria, while Lake Chad, a major source of water in the region, is reported to have been shrinking in size since the 1970s. Available evidence also shows that climate change has impacted on people's health.

The Nigerian agricultural sector is particularly vulnerable to climate change. The sector accounts for between 60-70% of the country's employment and contributes between 30-40% of its GDP. This makes the climate change issue a particularly significant challenge for the country.

The impact of climate change on rice cultivation

To get more information on the impact of climate change on Nigeria's agriculture, the CEEPA study assessed its potential economic impact on the country's rice cultivation. Recent research has shown that rice can be used to offset the major impacts of climate change because of its potential and unique properties as a food crop for the urban and rural poor.

Rice is already a major cereal in Nigeria in terms of its output and land area. Production has recently grown at an average of 14% per annum and currently stands at over 3.6millions tons of paddy rice per year, making Nigeria by far the largest rice producer in sub-Saharan Africa.

The major environmental problems that can seriously damage rice production include drought, flooding, salt stress and extreme temperatures. All of these challenges are expected to worsen as the effects of climate change take hold. However, so far, there has not been any study to address the economic impacts of climate change on rice farming. Nor have their been any studies that have looked at the farm-level adaptations that rice farmers can make to mitigate the potential impact of climate change.

A 1% increase in January temperature reduced irrigated rice net revenue by 0.5% but reduced dry land rice net revenue by more than 10%.

Assessing land values and net revenues

To help fill this information gap, the CEEPA study employed an econometric approach known as the Ricardian method. This allowed the researchers to look at how changes in climate affect the per hectare land values and net revenues of rice farms. It also allowed the researchers to assess the importance of irrigation as a way for Nigerian rice farmers to mitigate the likely impact of climate change on their crops. The distinction between irrigated and non-irrigated rice cultivation is very relevant in Nigeria since farmers often have to use irrigation to counter the effects of prolonged droughts. In 2005, irrigated rice production accounted for up to 20% of the country's total rice area.

As well as looking at the impact of past climate changes, the researchers also simulated the impact of future climate change scenarios on Nigeria rice agriculture. In these simulations, only climate variables were changed and all other factors remained the same. The researchers looked at the impact of three climate change scenarios: (i) an increase in temperature of 2°C, (ii) a decline in rainfall by 5% and (iii) a simultaneous increase in temperature of 2°C and a decrease in precipitation of 5%.

Land value was measured in terms of the rent paid by the farmers. Net revenue was assessed by calculating the value of the farmers' crops (the product of the total harvest and the price of the crop) and subtracting associated production costs. These costs included expenditure on transport, packaging, marketing, storage, post-harvest losses, fertilizer and pesticide.

Information on temperature, precipitation and farmers

To undertake this assessment, farm-level data on net-revenues (and their determinants) were collected from 1,200 randomly selected rice farmers. These farmers worked land in all of Nigeria's agro-ecological zones. The survey covered 20 states in all and assessed all the major rice producing regions in the country. This comprehensive coverage was important, as there are significant variations in temperature and precipitation levels between the different states in Nigeria.

A sample of 60 rice farmers was randomly selected from each state. This gave a total of 1,200 respondents, 483 of whom were farmers of irrigated rice and 717 of whom were dry land rice farmers. Information was collected using a structured survey questionnaire developed by Yale University and the University of Pretoria.

Information was gathered on the climate and soil types in each of the study farms. In particular, records were obtained of the monthly mean precipitation levels and average temperatures for the years 1970 to 2007. These records were provided by the Nigeria Meteorological Agency at Oshodi in Lagos, Nigeria and the International Institute for Tropical Agriculture (IITA) in Ibadan, Nigeria. When the records were assessed, the researchers took into account seasonal variations in temperature and precipitation.

Detailed soil data was also gathered for the 20 states. This data was obtained from the Food and Agricultural Organization (FAO). The FAO provided information about the major and minor soils in each location, including data on slope and soil texture.

Finding out about the farmers

The researchers also looked at the characteristics of the selected farmers and their households so that these variables could be taken into account. Information was gathered on farmers' education levels. This was done because educational level can affect the ability of farming households to adopt new technologies and optimize farming and marketing practices. The survey also obtained information about the farmer's agricultural experience, which was expected to have a positive impact on farm profitability.

The socio-economic data obtained from the survey also included information on the gender of the household head, household size, farm size, educational status, access to public extension services, access to credit, the amount of crop consumed and sold, the use of machinery, the cost of labour used, and the distance from farms to the markets where crops were sold.

The study found that, on average, the net farm revenue per hectare for irrigated rice farms was N31,382.63. The figure for dry land farms was N23,432.59. The mean value of land rent per hectare for irrigated rice farms was also greater than that for dry land rice farms. The values were N3,523.67 and N2,580.76 respectively. The average total area that farmers devoted to rice cultivation was 3.76 hectares. This suggests that rice farming in Nigeria is still predominantly on a small scale. More land area, on average, was devoted to dry-land rice farming than to irrigated rice farming.

The significant impact of climate change

The study found that climate change has a significant impact on rice agriculture in Nigeria. It found that both net revenue and land rent per hectare are sensitive to marginal changes in temperature and precipitation. Importantly, the results indicate that temperature rises are less harmful to irrigated rice farms than to dry land rice farms. This is thought to be because irrigation buffers the crop from rainfall shortages.

For example, the researchers found that, while a 1% increase in temperature would decrease the net-revenue per hectare for irrigated rice farms by 6.79%, it would decrease it by 15.72% for dry land rice farms. A 5% reduction in precipitation would give similar results and would lead to decline in net-revenue for both irrigated and dry land rice agriculture.

The study shows that the impact of climate changes varies according to the time of year. For example, a 1% increase in January temperature reduced irrigated rice net revenue by 0.5% but reduced dry land rice net revenue by more than 10%. Furthermore, the results showed that higher temperatures in July and October were harmful to both irrigated and dry land rice farming while a higher temperature in April was beneficial.

With regard to land rents, the study found that a 2% increase in temperature at current levels of rainfall would decrease the value of land for both irrigated and dry land farm. The same would be true for a 5% reduction in rainfall at current temperature levels.

Climate Variable	Climate Scenarios	Irrigated	Dry
Temperature	+2 °C	6.79	-15.72
Rainfall	-5%	32.53	-75.13
Both temperature and rainfall	2°C rise in temperature &	17.20	-35.27
	5% reduction in rainfall		

Impact of Changing Only Temperature or Rainfall on Rice Net Revenue in Percentages

The importance of irrigation

The results show that irrigation has proved to be an effective adaptation measure to reduce the harmful effects of climate change on rice agriculture. This throws up a significant challenge as most river basins in Nigeria are under-performing. They are already ineffective at meeting the irrigation demands of rice farmers in Nigeria. Further investments are therefore required to improve the irrigation systems in terms of both facilities and manpower.

Since the study found that land rent was more sensitive to marginal changes in climate variables than net revenue, the researchers suggest that policy efforts should be geared towards having a well-functioning land market in the nation. They advise that the on-going review of the use of the nation's land should give this issue serious consideration.

The study concludes that, by and large, given the increasing investment of the Nigerian government in increasing rice production, policy makers should encourage and support wider research and deeper analyses of the impact of climate change on the country's agriculture.

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Centre for Environmental Economics and Policy in Africa (CEEPA) University of Pretoria, Room 2-7, Agricultural Annex, 0002 PRETORIA, South Africa. Tel: +27 (0) 12 420 4105, Fax: +27 (0) 12 420 4958. www.ceepa.co.za