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How is extreme weather affecting Nigeria's crops and what are the implications for its agricultural insurance?

Abstract

In sub-Saharan Africa, as in much of the developing world, extreme weather events and climatic anomalies are having serious effects on agriculture. However, at present, little evidence exists on how changes in climatic conditions in the region are affecting crop yields. To help shed light on this unfolding crisis, this CEEPA study assesses how extreme weather conditions affect crop yields in Nigeria and looks at the implications this has for crop insurance in the country.

The results show that high temperatures are having a significant negative impact on yields of cassava, cotton and maize. Even more worryingly, the study shows that temperatures that were expected to be beneficial are already negatively affecting sorghum and rice yields. The study recommends that long-term improvements in areas such as irrigation and crop varieties are vital. However, it highlights that farmers need help in the short term and suggests that this could be provided by the development of a weather-index crop insurance scheme based on information from Nigeria's Meteorological Agency.

Nigerian agriculture is threatened by climate change

A summary of CEEPA Discussion Paper No. 16: Effects of Weather Extremes on Crop Yields with Implications for Crop Insurance in Nigeria by Joshua Olusegun Ajetomobi from Ladoke Akintola University of Technology, in Ogbomoso, Nigeria

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Report Summary

Nigeria is one of many African countries that are already being affected by climate change. Partly in response to this challenge, major advances have been made in recent decades in both short-term and seasonal weather forecasting, as well as in long-term climate modeling. These developments have allowed Nigeria's policy makers and farmers to place more emphasis on managing the risk that agriculture faces from extreme weather events.

Each year, a large amount of government money is devoted to subsidize premiums for insurance policies that reduce agricultural risk and to make ad-hoc payments to reimburse farmers after they are affected by natural disasters. That said, crop insurance in Nigeria still covers less than 1% of the total population of farmers (it is often only applied when financial institutions impose it as a condition for formal credit). In light of this situation, it is expected that insurance and other weather-related costs will continue to increase as the impact of climate change grows and the country experiences more extreme weather events.

This situation makes it vital for Nigerian policy makers to have adequate knowledge about the effects of weather extremes on the yields of the main crops that are grown in the nation. In light of this, the main objectives of this study were to: 1) estimate the effect of extreme weather on yields for the following major Nigerian crops: cassava, cotton, maize, rice, and sorghum (crops that are highlighted as being vital to the nation's wellbeing in its Agricultural Transformation Agenda). 2) Draw out the potential implications of its findings for the nation's crop insurance scheme.

> **"Weather index insurance should be incorporated into the National Agricultural Insurance Scheme (NAIC)."**

Assessing how climate affects crop yields

The study used the Ordinary Least Square approach to analyze the relationship between weather fluctuations and crop yields. Annual crop yields for the five major crops under consideration were obtained from the official records of Nigeria's Agricultural Development Programme. This information is available for all states in the country for the period between 1991 and 2012. The records include information on total crop production levels, land areas, the number of farmers growing each crop and the crops' market prices.

The study assessed the impact of three key temperature variables. These were average temperatures, Growing Degree Days (GDD) and Harmful Degree Days (HDD). GDD is a measure of the number of heat units crops are exposed to during a growing season. It was defined in this study as days when the temperature was between eight and 31 °C. HDD were defined as periods during which the temperatures was greater than 34 °C.

Another variable that was considered was vapor pressure deficit (VPD). VPD is calculated as the difference between how much water the air can hold when it is saturated and how much water it currently holds. VPD drives water loss via plant transpiration, thereby increasing water requirements. VPD also affects diurnal temperature variation, cloud cover and precipitation. Theoretically, a positive relationship is expected between VPD and yields when soil moistures are adequate. A decreasing relationship between these two variables is expected when soils moisture levels are inadequate.

Key weather data

The climate data used in the study came from the National Meteorological Agency (NIMET) in Lagos and was derived from the records of 32 weather stations. Between them, these provided temperature information from all the states in the country. The data consisted of daily observations of maximum and minimum temperatures and precipitation levels from 1981 to 2012.

The figures show that temperatures above 30 °C have been common but that temperatures above 40 °C have been less common. Daily maximums between 30 and 35 °C occurred more than a 1,000 times for most months. The highest temperature in the weather dataset was 46 °C, which occurred in the months of March and April.

Rainfall data were obtained from NIMET in the form of daily rainfall levels measured in millimeters. These readings were summed over the entire growing season for each of the selected crops. The lowest cumulative rainfall recorded for any growing season was 19.6 mm while the maximum was 4,243.1 mm. The average varied from 469.7 mm to 1,495.1 mm.

Summary Statistics for Cummulative rainfall

Crop	Minimum	Year	Maximum	Year	Mean
Cassava	366.2	1999	4243.1	2008	1495.1
Maize	19.6	1992	2937.9	2009	1065.4
Cotton	426.6	1992	1789.4	1995	939.4
Rice	24.5	1992	2361	2004	469.7
Sorghum	366.2	1991	1935.4	2007	896.5

The growing seasons for the selected crops varies, depending on whether the crop is grown in the northern or southern part of Nigeria. The following major growing seasons were used in the analysis: Maize from March to October (to cover both early and late maize seasons), sorghum from April to August (since it is predominantly grown in the Guinea and Sahel savannah regions), cotton from June to February after the first year, rice from April to December and cassava from January to December.

All key crops affected by extreme temperatures

As expected, it was found that extreme weather was having a significant negative impact on the yield of all the crops, especially cassava, cotton, maize and sorghum. For example, when temperatures were 34 °C and above (i.e. during HDDs) a 1 °C increase in temperature led to a 0.18 kg/hectare decrease in cassava yields, a 0.18 Kg/hectare decline in cotton yields and a decline of about 0.01 kg/hectare in maize yields.

While most of the crops achieved higher yields when temperatures within the GDD range went up this was not the case for rice and sorghum. In other words, for cassava and sorghum an exposure to a heat range that is expected to improve yields is already having a negative effect.

The relationship between yields and rainfall was positive for all the crops except cotton. While, in contrast to theoretical expectation, a negative relationship was found to exist between VPD and cassava yields. This implies that soils moisture for the growth of cassava in Nigeria is inadequate. A similar finding was made for maize. Overall, VPD were found to have a stronger influence on yields for most of the crops than any other of the other variables.

Short- and long-term action now urgent

Given the clear evidence this study provides that extreme weather is already having a negative effect on Nigeria's key crops, it is clear that significant steps must be taken to help farmers adapt. Possible adaptation measures include the development of irrigation and other infrastructure, the implementation of flood controls and the development and use of crop varieties that are resistant to weather extremes. These measures are, however, costly and will take time to put in place.

The study recommends that an innovative short-term way out of the problem is to improve the country's National Agricultural Insurance Scheme (NAIC). The study highlights various problems associated with the NAIC, including the fact that it is difficult for farmers to access and that it features high transaction costs. The study therefore recommends that more should be done to help farmers to take advantage of the scheme, however, it also highlights the need for more radical improvement, including the development of weather index insurance.

How to put the WIIA in place

The overriding aim of Weather Index Insurance for Agriculture (WIIA) is to alleviate the negative impacts of extreme weather on farming households and village economies by compensating them for part of the damage caused by these weather events. Such insurance products are already available in Japan, the U.S. and EU member countries. Under these schemes, insurance claims are paid according to the number of days when temperature either falls below or exceeds certain agreed levels.

An advantage of WIIA is that the actual damage to the crops of individual farmers need not be measured and verified. Instead, compensation is automatically paid out when a certain set of conditions are satisfied. Other advantages of index insurance include rapid payouts and low transaction costs.

The study advises that WIIA should be incorporated into Nigeria's NAIC. It cautions that the following points should be kept in mind: 1) WIIA does not eliminate the risk of extreme weather conditions. Hence, considerable priority should still be placed on how to reduce greenhouse gas (GHG) emissions through mitigation measures. 2) The Insurance does not eliminate the need for infrastructure development. It should be seen as a supplemental option. In this context, it should be considered as a short-term approach to alleviate the impact of extreme weather until infrastructure is fully developed and weather conditions return to their prior stable state.

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