POLICY BRIEF

October, 2014

UNU-INRA

Volume 2 No. 6

ADAPTING TO AGRICULTURAL INTENSITY AND CLIMATE IMPACTS ON CROP YIELDS

By: Peter Ikemefuna Ezeaku

INTRODUCTION

Persistent land degradation in the form of soil erosion, nutrient depletion, soil organic matter depletion and soil productivity decline as well as variability in rainfall and temperature could negatively impact food security in most African countries. These concerns are particularly relevant in South-eastern Nigeria where land is intensively cultivated by local farmers. This calls for a different approach in the management of soil, land and water in order to improve soil productivity so as to achieve food security and reduce poverty in the country.

This policy brief examines how agricultural intensity and climate change will impact crop yields across the three agro-ecological zones (AEZs) in Southern Nigeria.

A Cassava Farm in South-eastern Nigeria

Context and Importance of the Problem

Resource poor farmers abound in South-eastern Nigeria and they cultivate small plots of land and experience lower crop yields. There has been a reduction in soil productivity driven by high population density and climate effects. This has resulted in

UNITED NATIONS UNIVERSITY
UNU-INRA
Institute for Natural Resources in Africa
www.inra.unu.edu

land degradation and loss of productive capacity of the land in terms of soil fertility and soil bio-diversity. According to the Millennium Development Goals, improving and maintaining agricultural productivity is critical to achieving food security and poverty reduction.

Land degradation and variability in average temperatures and precipitation do not only threaten sustainable agricultural production, food security and the socio-economic conditions of the population, but also the environment (UNU/INRA, 1997). Key questions that emerge as research concerns are: to what extent are soil and climate variability impacting crop yields, and what agricultural strategies are needed to meet these challenges in South-eastern Nigeria?

METHOD

Soil samples were collected from three locations within Southern Nigeria. These were collected at the derived savannah in Nsukka, Enugu State, the low land rainforest in Umuahia South, Abia State, and the fresh water swamps in Ikot Abasi, Akwa Ibom State. A total of ninety augers and thirty six core soil samples were collected and adjacent fallow soils were studied for standardisation. In addition, a random selection of ninety participants from the list of community members provided by community leaders was done. These included heads of households with at least 20 years farming experience.

A survey instrument was used to collect information on four staple crops: cassava, rice, maize and cowpea in the study locations. Information on the relationship between adapted land management practices and soil productivity was gathered through open-ended questions. Average yearly rainfall and temperature data from 2000 to 2011 was collected from the meteorological stations close to the study sites.

Soil chemical and physical properties such as pH, organic carbon, available phosphorus, Cation Exchange Capacity (CEC) were determined following standard laboratory methods. Soil fertility and land degradation assessments were also carried out in addition to soil characterisation (Aune & Lal, 1997). Soil degradation rating (SDR) was based on the weighting scale of 1 to 5, where 1 is none, 2 (slight), 3 (moderate), 4 (high) and 5 (severe).

DATA ANALYSIS

The data was quantitatively analysed using STATA Version 12, and Genstat 9.2 Edition. Coefficient of variability (CV %) was used to assess the variation in climate parameters over the 12 year period. Anomaly was calculated as the departure of rainfall and temperature annual values from the normal annual mean for each location. Rainfall and temperature effects on crop yields were obtained through regression analysis.

RESULTS

The study found anomalies and variations in rainfall and temperature over the 12 year period observed (2000 – 2011). The anomaly result showed that rainfall and temperature years were below the normal values for some locations (Nsukka, Umuahia South and Ikot Abasi).

The results also revealed that rainfall decreases and temperature increases were likely to occur in the future, which would impact negatively on crop yields.

Interaction effects of rainfall, temperature and soil properties on crop yields showed that temperature increases had a much stronger impact on crop yields than rainfall (precipitation) decreases.

As presented in the Table below, a unit increase (or decrease) in any of the variables (rainfalls, temperature, and soil degradation) leads to a unit increase (or decrease) in crop yield respectively. While rainfall decreases reduced the yields of cassava, cowpea and rice, temperature increases impacted negatively on the yields of all crops studied in the following order: cassava (0.6473kgha-^{1}), maize (0.0613kgha-^{1}), rice (0.0450kgha-^{1}) and cowpea (0.0323kgha-^{1}).

The interaction effect of all the parameters on the crop yield variation followed similar order with 72, 24 and 22% observed for cassava, cowpea and rice, respectively.

Thus, continuous decrease of these crop yields by every unit (1^{o}C) increase in temperature and decrease in rainfall has critical negative implication for food security.

With regard to agricultural management practices used by farmers, the results showed that the most common traditional practices employed by farmers included intercropping (32%), composting/residues manure (30%), slash and burn (23%), and inorganic fertiliser use (15%). Increasing soil organic carbon, soil fertility and productivity, as well as reduction of soil erosion were common reasons provided by the farmers for using most of these management practices.

Table 1: Effect of rainfall, temperature and soil degradation rates on each crop yield across study locations

Parameters	**Cassava**	**Maize**	**Cowpea**	**Rice**
Rainfall (r mm) SE	-0.0010 (0.0064)	0.0010 (0.0022)	-0.0002 (0.0007)	-0.0007 (0.0023)
Temperature (t ^{o}C) SE	-0.6473 (0.4796)	-0.0613 (0.1833)	-0.0323 (0.0616)	-0.0450 (0.2042)
Rainfall x Temp (rt) SE	0.0000 (0.0002)	-0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Soil degradation rate (SDR) SE	-6.6739 (0.2552)	0.0055 (0.1287)	-0.0359 (0.0319)	1.5801* (0.8709)
R^2	**0.7190**	**NA**	**0.2192**	**0.2358**

Note: Values in brackets are the standard error, NA= not available *P<0.01

Source of Table: Computation from Author's data

RECOMMENDATIONS

1. To address the anomalies in rainfall and temperature variability, adapting and planting diversified crop varieties could serve as protective measures to extreme weather conditions. In addition, making furrows and bonds in farms to retain water is also an important antidote to temperature increases.

2. To enhance green soil conservation and growth, land and water management have to change in order to improve soil productivity. This could be done through the adaptation of any of the suggested measures below:

- Land users can manage their soil to give it maximum physical resilience through a stable, heterogeneous pore system by maintaining a closed ground cover as much as possible. This can be achieved through incorporation of leguminous crops into traditional farming methods as well as leaving crop residues on farms to serve as mulch and soil cover so as to armour the soil against future climate change impact.

- Combined use of lime (e.g. oxides or carbonates of Ca and Mg), organic manure (e.g. poultry droppings and cow dung) and inorganic fertiliser as integrated plant nutrient management system could also balance the input and nutrient offtake, at the same time maintain soil nutrient levels low enough to minimise losses and high enough to buffer occasional increase demands.

- Conversion to contour ploughing and the establishment of vetiver grass hedges in-between cultivated crops would also reduce soil erosion and enhance the agricultural potentials of the soils in the study locations.

REFERENCES

Aune, JB & Lal, R 1997, 'Agricultural productivity in the tropics and critical limits of properties of oxisol, ultisol and alfisol'. Tropical Agriculture, Vol.74, pp. 96-103.

United Nations University/Institute for Natural Resources in Africa (UNU/INRA), 1997. 'UNU in Africa: Managing Natural Resources for Sustainable Development'. UNU Publication, pp. 5-11.

ABOUT THE AUTHORS

Dr Peter Ikemefuna Ezeaku is a Senior Lecturer and the Head of Department of Soil Science in the Faculty of Agriculture, University of Nigeria Nsukka, Enugu State, Nigeria. He produced this Policy Brief during his Visiting Scholarship Programme at UNU-INRA.

This Policy Brief is prepared from a UNU-INRA Working Paper entitled:

Agricultural Intensification and Climate Effect on Soil Productivity in South-eastern Nigeria

by Peter Ikemefuna Ezeaku as part of UNU-INRA's Visiting Scholars Programme.

CONTACT

United Nations University Institute for Natural Resources in Africa

Location: Second Floor, International House, Annie Jiagge Road, University of Ghana, Legon, Accra, Ghana

Address: PMB, KIA, Accra, Ghana

Email: inra@unu.edu,

Website: www.inra.unu.edu,

Tel: +233 302 500396