Feed the Future Innovation Lab for Food Security Policy

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Exploring Maize Production in Nigeria Under Climate Change Using System Dynamics

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Introduction

While there is broad consensus that West African countries will experience (and perhaps are already experiencing) adverse effects of climate change on crop yields and productivity, estimates of these impacts range widely because of deep uncertainties in the complex socio-ecological systems responding to climate change, and in the climate system itself. In addition to climatic uncertainty, adaptation measures and cropping systems which vary widely at the regional, state, and local levels in Nigeria will also influence the differential impacts of climate change on agriculture in different parts of the country. In this brief, we introduce a system dynamics model representing production of maize at the national scale in Nigeria under the direct impacts of climate change described by stakeholders at the June 2016 workshop: drought, flooding, and heat. This model is intended as a tool for dialogue between researchers and stakeholders leading up to the development of downscaled models of crop production under climate change in Kaduna and Ebonyi states.

The quantitative simulation model was developed from a causal loop diagram (CLD) generated by stakeholders from multiple regions of Nigeria in June 2016. A detailed description of the diagramming exercise, and the CLD itself, may be found in a previous report 1. The CLD represents the causal logic and relationships which drive the model. In order to simulate the model, these relationships have to be translated into equations using Vensim® software. The datasets used to parameterize the model include the Living Standards Measurement Study (LSMS) data from Nigeria dating from 2012; historical data on yield, production, and area under maize from the United Nations Food and Agriculture Organization's FAOSTAT database; population data from the United Nations Population Division; and historical climate data from the World Bank's Climate Change Knowledge Portal, as well as other data published in peer-reviewed journal articles, all of which are listed in the Appendix. The model was demonstrated for a group of stakeholders at IFPRI offices in Abuja, Nigeria on March 9, 2017.

Key Findings

- Under the baseline model run (without climate change), net production of maize in Nigeria (that is, production – national consumption) is expected to increase approximately three-fold by 2064
- Model output is consistent with meta-modeling studies that demonstrate potential yield losses of up to 50% by mid-century in West Africa under climate change, with the median yield loss at 11%.

Under the baseline model run (without climate change), net production of maize in Nigeria (that is, production – national consumption) is expected to increase approximately three-fold by 2064, assuming the rates of maize yield increase and consumption per capita increase remain the same (Figure 1). With all climate impacts considered, Nigeria would have a net negative production of maize—that is, would fail to produce enough maize to satisfy domestic consumption—in 10 out of 60 years between 2014 and 2064, according to the model. A main goal of the initial model development was to get feedback from relevant stakeholders in anticipation of the development of downscaled production models for Kaduna and Ebonyi states. Participants at the March 9 meeting

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were interested in seeing the relative effectiveness of different climate change adaptation strategies to mitigate yield losses from climate change, and how changes in the Nigerian food system could affect the supply chain of maize in the face of climate change.

This model was not intended to be used in a predictive manner as a policy tool. It is part of an ongoing participatory modeling process that will culminate in state-level models of potential climate change impacts on important food crops in Kaduna and Ebonyi states, which will take place over the 2017-18 project year. Nevertheless, model output is consistent with meta-modeling studies that demonstrate potential yield losses of up to 50% by mid-century in West Africa under climate change, with the median yield loss at 11% 2. This gives us confidence to go forward with the downscaling of the model to Kaduna and Ebonyi states, using the model structure developed through the participatory stakeholder consultation, and incorporating stakeholder feedback.

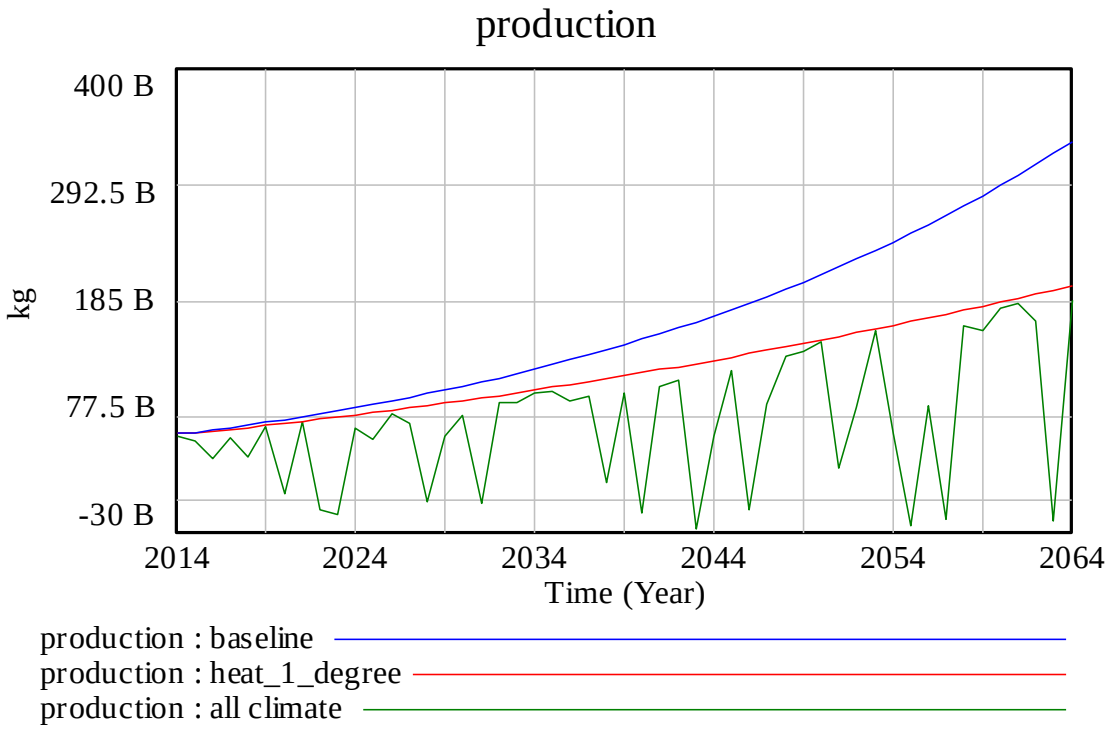

Figure 1: Modeled maize production in Nigeria to 2064 under baseline conditions (blue line); a 1°C increase in temperature (red line); and under a 1°C increase in temperature, combined with periodic drought and flooding (green line).

Key References

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