East African Agriculture and Climate Change:

A COMPREHENSIVE ANALYSIS — UGANDA

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CURRENT CONDITIONS

Uganda occupies a total area of 241,038 square km, most of which is suitable for agriculture. Sixteen percent of the total area is water and swamps, while 7 percent is forested. Maize, beans, cassava, and banana (plantain) are the most widely grown crops.

Uganda's climate is regarded as its most valuable natural resource, one central to the livelihoods of many Ugandans. However, the last few decades have been marked by climate variability that has given rise to more frequent extreme weather events, such as droughts, floods, and landslides, damaging natural resources and hindering social and economic development.

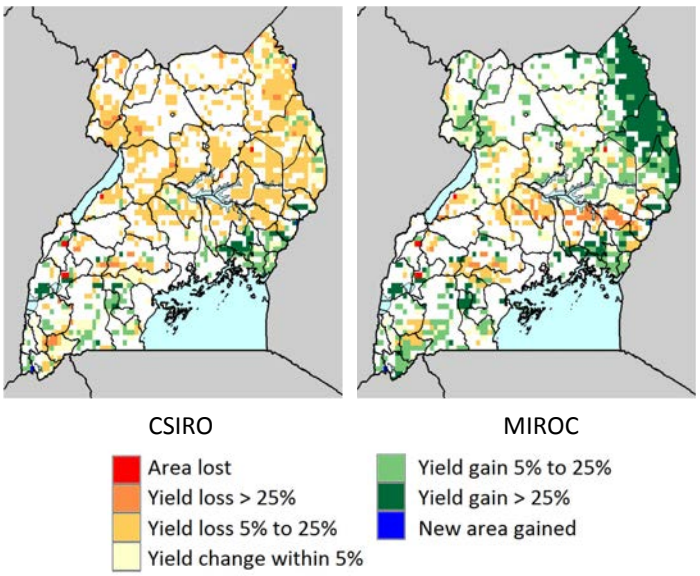
The country's population grew by 3.7 percent between 2009 and 2010 (to a total of 32 million people). The population is expected to reach 103.2 million in 2050, assuming growth declines to 2.9 percent per annum between 2040 and 2050. The population remains predominantly rural (85 percent in 2010). At 50 years, life expectancy remains low. Malaria is the most prevalent fatal illness. The poverty rate is down from 31 percent in 2006 but, at 24.5 percent, remains high.

CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

Four downscaled global climate models (GCMs) from the IPCC AR4 were used. The models are quite diverse in their projections of changes in average annual rainfall between 2000 and 2050. The MIROC model is "wettest", with a median precipitation increase of 150 millimeters and a peak near 250 millimeters. The "dry" model is the CRNM model, in which the southeastern quarter of Uganda is projected to receive more than 100 millimeters less rain per year, while most of the rest of the country experiences no significant change. The CSIRO model projects that rainfall will decline in the southwest rather than the southeast, and that it will be unchanged throughout most of the rest of the country.

While all four GCMs predict temperature increases, there are important differences in the amount of the increase between 2000 and 2050, as well as some regional variations. The MIROC model suggests that the daily maximum temperature of the warmest month will increase by about 1°C on average; CSIRO model predicts temperatures only slightly warmer. However, the other two GCMs predict temperature increases almost 1°C above that.

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED MAIZE



The maps above depict the results of the Decision Support System for Agrotechnology Transfer (DSSAT) crop modeling software projections for rainfed maize, comparing crop yields for 2050 with climate change to yields with 2000 climate. The models diverge in their predictions of the climate's impact on yield. The MIROC model results in increases in maize yields, and in many places that increase will be greater than 25 percent. For the most part, the CSIRO model predicts that climate change will reduce yields. It is much more difficult to generalize from these results, because even in locations where annual rainfall was to increase, the model foresees yield reductions. One way to understand this is that while the figures showed annual rainfall changes and temperature changes in the warmest month, crop models respond to rainfall and temperature during the months in which the crop

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is growing. As an example, annual rainfall might be reduced in spite of an increase during the growing season.

CLIMATE CHANGE & FOOD SECURITY SCENARIOS

The research used the IMPACT global model for food and agriculture to estimate the impact of future GDP and population scenarios on crop production and staple consumption, which can be used to derive commodity prices, agricultural trade patterns, food prices, calorie consumption, and child malnutrition. Three GDP-per-capita scenarios were used – an "optimistic scenario" with high per capita income growth and low population growth, a pessimistic scenario with low per capita income growth and high population growth, and an intermediate scenario.

For Uganda, per capita income almost triples between 2010 and 2050, even in the pessimistic scenario. The intermediate scenario shows a six-fold increase in income; the optimistic scenario, an eight-fold increase.

The data suggest that maize yields will triple by 2050. Since little change is projected in the area under cultivation, production also triples. This increase is much higher than what the crop models project because technological improvements in the agricultural sector are included in the IMPACT model.

There is very little difference in IMPACT projections of maize yield between scenarios, but there is almost a 20 percent difference in yield between the results for the climate model with the lowest yield and the one with the highest yield.

Net maize exports are projected to grow, with production surpassing the demands of a rapidly growing population. The world price of maize is projected to double during that time period.

The country's cassava yield is projected to increase by around 80 percent between 2010 and 2050. But with a projected decrease in area of around 15 percent, production will expand by only 40 percent. The increase in production is too little to keep pace with domestic demand, and imports of cassava are projected to rise.

The difference in median yields across scenarios is only about 4 percent from lowest to highest. But the difference in yields between climate models is around 20 percent from lowest to highest.

Uganda has recently been selected by the World Bank as a Center of Excellence in cassava production. This is a large IDA credit for investment in agricultural productivity, which should spur technology development, dissemination, and adoption, further contributing to yield increases for cassava. Furthermore, as cassava is known to thrive in a range of environments, tolerating both drought and high rainfall, its production may be less affected than other crops by climate change.

In practice, it is doubtful that Uganda will import substantial amounts of fresh cassava and other roots and tubers, owing to the perishability and bulkiness of these commodities and the current low levels of processing technology, although this may change in the next 40 years. An informal cross-border trade survey reports imports of cassava, sweet potato and potato imports already occur.

The IMPACT model projects that the number of malnourished children under the age of five years will increase initially, and then decline between 2025 and 2040. For the optimistic and intermediate scenarios, the number of malnourished children will be less in 2050 than in 2010. Nonetheless, while absolute numbers of malnourished children rise for some time, the proportion of children who are malnourished declines steadily because of rapid population growth.

In the pessimistic scenario, per capita calorie intake will not change by much. But the projections show a great improvement for the baseline scenario and even more for the optimistic scenario. Generally speaking, the data suggest that Uganda will be a net food exporter, although localized hunger may exist in remote areas of the country owing to security problems, poor road networks, and natural disasters. The main nutrition concern relates not to calorie availability but rather to "hidden hunger," which is driven by micronutrient deficiency.

RECOMMENDATIONS

To facilitate adaptation of agriculture to climate change, policymakers should:

- enforce laws to control deforestation and encroachment on fragile landscapes such as wetlands; and
- invest in research to help identify alternative livelihoods for those in areas that may be adversely affected by climate change.

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