East African Agriculture and Climate Change:
A COMPREHENSIVE ANALYSIS — TANZANIA

CAROLINE KILEMBE[1], TIMOTHY S. THOMAS[2], MICHAEL WAITHAKA[3], MIRIAM KYOTALIMYE[3], SIZA TUMBO[4] DECEMBER 2012

CURRENT CONDITIONS

The sustainable development strategies of the Tanzanian government's National Development Vision 2025 emphasize agriculture and food security as the keys to poverty alleviation. Maize is the country's most important staple, followed by sorghum, rice, beans, and cassava. Per capita income has increased since 1994, and the share of GDP contributed by agriculture has decreased slightly. In 2007, 70 percent of the population was engaged in agriculture, a sharp drop from almost 90 percent in 2006. More than 70 percent of adults are literate. The malnutrition rate for children under five years was about 15 percent in 2010.

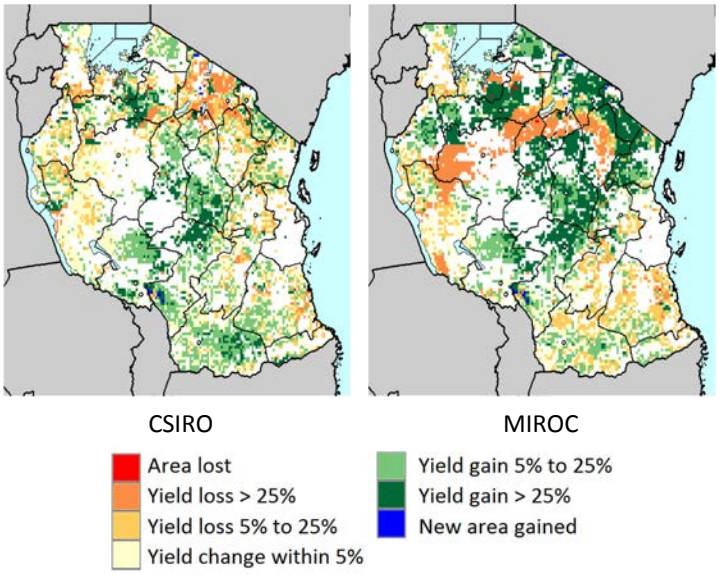
Both the mortality rate for children under five years and life expectancy at birth improved significantly between 1960 and 2010. However, climate change holds the potential to threaten these gains. Warmer temperatures and high levels of rainfall have been linked to the rising incidence of malaria and cholera. In primarily rural areas where residents are dependent on agriculture, poverty rates are as high as 95 percent, implying high levels of vulnerability.

CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

For our analysis, we used four downscaled global climate models (GCMs) from the IPCC AR4. Comparing the models' projections for annual precipitation changes between 2000 and 2050, the MIROC model is the "wettest," predicting increased rainfall across the entire country. Although the median increase in precipitation is around 200 millimeters per year, some areas would receive an annual increase of up to 300 millimeters. The CSIRO GCM showed no significant change in rainfall over approximately 60 percent of Tanzania, but a 50–100 millimeter increase over much of the country's eastern half.

All four models predicted higher temperatures by 2050. The CSIRO and MIROC models projected the lowest median temperature increases (about 1°C); the others projected median increases of 2°C or higher. The MIROC model exhibits the most spatial variability, with a change of less than 0.5°C near Lake Victoria, increasing as one travels southward, reaching as high as 1.5°C. The data suggest that temperatures will increase by 2°C at the eastern and western borders. Such increases could have negative consequences for agricultural productivity owing to the spread of diseases and crop pests.

CHANGES IN YIELD UNDER 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. With the MIROC model results, many areas show yield gains of more than 25 percent, although the results also show yields declining by more than 25 percent in other areas. In contrast, the CSIRO model suggests more moderate results, with yields rising or falling by less than 25 percent. The model also projects yield gains across most of southern Tanzania, whereas the MIROC model predicts the opposite. Rice yields showed gains in some regions and losses in others. The geographic variability makes generalizations unwise.

The results suggest that it would be helpful to prepare a number of responses from which farmers could choose.

[1]Ministry of Agriculture, Food Security, and Cooperation; [2]International Food Policy Research Institute (IFPRI); [3]Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA); [4]Sokoine University of Agriculture (SUA).

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.

The IMPACT model showed a slightly higher maize yield for 2050 than for 2010, which, combined with a slight increase in crop area, results in a small increase in overall production. There is virtually no difference in yield projections between scenarios, but there is about a 15 percent difference in yields between the climate model with the lowest yield and the one with the highest yield.

With such high population growth and little expansion of the area under cultivation, maize imports will rise. Since the international price for maize is projected to increase by 101 percent between 2010 and 2050 (averaged across the 3 scenarios and the 4 climate models), the amount spent on maize imports will be considerably higher than at present.

The modeling predicts that cassava yields will remain largely unchanged between 2010 and 2050. However, there is some variance between estimates. Yields are around 4 percent lower in the optimistic scenario than in the pessimistic scenario, and the climate model with the highest yields is 25 percent higher than the one with the lowest yield in any given scenario.

There is a slight increase in area, but ultimately production is not projected to change much. With population expected to at least double by 2050, demand for cassava will far outstrip supply, leading to a dramatic rise in imports. Unlike the case of maize, world prices for cassava do not rise as dramatically between 2010 and 2050, averaging only 26 percent when averaged across all scenarios and climate models.

The story for sorghum is completely different. Yields are projected to more than triple, with both climate change and technology improvements contributing. The area under production also expands by around 40 percent, leading total production to more than quadruple. With such an increase, Tanzania will be able to export around 70 percent of what it produces in 2050. The international price for sorghum is projected to increase by 23 percent between 2010 and 2050 (average across all scenarios and climate models).

The IMPACT model projects that rice yield will roughly double between 2010 and 2050. With a small increase in area, the production of rice will slightly more than double. However, with such a rapidly growing population, production will not keep up with demand, and imports of rice will rise. The analysis projects that the international price for rice will increase by 55 percent between 2010 and 2050.

The model predicts that the number of malnourished children will increase until the year 2025. That number begins to fall earlier in the optimistic scenario than in the baseline and pessimistic scenarios. With population rising, gradual increases in the number of malnourished children actually reflect a gradual decline in the malnutrition rate. Mean calorie consumption is projected to remain unchanged until around 2030, and then is projected to rise. The increase will be small in the intermediate and pessimistic scenarios, but will be around 30 percent in the optimistic scenario.

RECOMMENDATIONS

To minimize the effects of climate change, strategies are needed to enhance agricultural productivity and promote investments in agricultural research and extension. Policymakers should:

- establish a legal framework to protect unsettled areas or to assist farmers in relocating;
- fund national agricultural research institutes and extension services; and
- shore up the social safety net to prevent people from dying or falling into deep poverty, and to help farmers recover from setbacks.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
2033 K Street, NW • Washington, DC 20006-1002 USA
T: +1.202.862.5600 • F: +1.202.467.4439
Skype: ifprihomeoffice • Email: ifpri@cgiar.org

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