East African Agriculture and Climate Change:

A COMPREHENSIVE ANALYSIS — RWANDA

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CURRENT CONDITIONS

The Rwandan economy is based on rainfed agriculture, with coffee and tea as major cash crops. The key staple crops are bananas, beans, potatoes, sorghum, and cassava. Between 1991 and 2002, the rate of urbanization grew from 5.5 to 16.7 percent, a function of rural exodus, the return of refugees who from the 1994 genocide, and improvements in health and well-being in Rwanda. Life expectancy and child mortality rates in the country are influenced by a wide range of diseases, including malaria, diarrhea, and HIV/AIDS. Progress in reducing poverty has been very slow in spite of strong economic growth. In 2006, 57 percent of the population lived below the national poverty line; 37 percent were considered extremely poor because they could not afford the necessary minimum calorie requirements. Poverty declined most in urban areas. In rural areas, poverty declined from 66.1 to 62.5 percent.

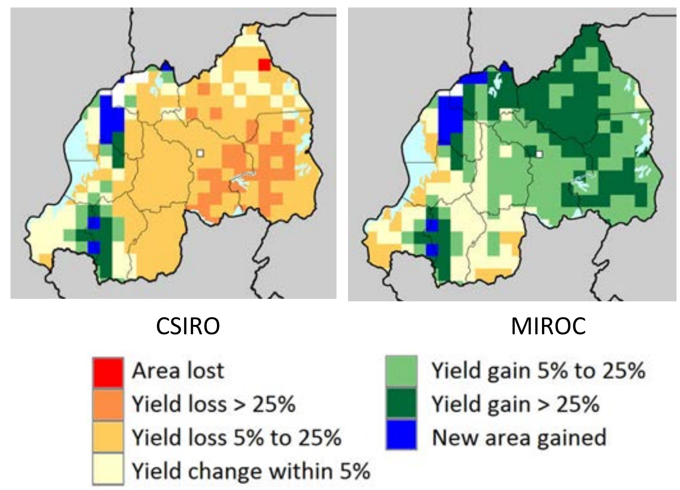
CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

For our analysis, we used four downscaled global climate models (GCMs) from the IPCC AR4. While the CNRM and ECHAM models agree that there will be little change in annual precipitation between the climate of 2000 and the climate of 2050, the other 2 models diverged: The CSIRO model foresees a drier future, with annual rainfall declining 50–100 mm per year; while the MIROC model predicts a wetter future, with rainfall increasing 200 mm per year on average. This disparity suggests that plans and policies must be flexible enough to benefit farmers under various climate outcomes, or that policymakers must be able to formulate and adjust policies as researchers report on changing climate conditions.

The models project temperature increases of 1–2.5^{0}C (CSIRO predicts an increase of 1–1.5^{0}C, whereas MIROC indicates slightly higher temperatures in the western half of the country). Higher temperatures are likely to have an adverse effect on crop yields. However, the use of varieties adapted to warmer temperatures could help maintain productivity. Higher temperatures may also favor plant pest and disease multiplication, as well as increased transmission of human diseases, particularly malaria parasites. These effects could be mitigated through the use of pesticides, pest-resistant plant varieties, and the expansion of appropriate health services.

The maps above depict the results of the Decision Support System for Agrotechnology Transfer (DSSAT) crop modeling software projections for rainfed sorghum, comparing crop yields for 2050 with climate change to yields with 2000 climate. There is a great deal of variation between models, and there is observable geographic variation within most models. The two models predict substantially different yields. The MIROC model, with modest temperature increases and significant rainfall increases, results in possible gains of more than 25 percent in most of the eastern half of the country. In contrast, the CSIRO model, with modest temperature increases and lower rainfall, results in losses of 5–25 percent over most of the country. One point of agreement between the models is that sorghum production will become possible in some higher-elevation areas in the west that were previously too cold. Boosting sorghum production is important for improving the nutrition of mothers and children, as well as

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED SORGHUM



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generating income. However, cultivating new lands may also damage natural resources, especially since these new zones of production appear to be in protected areas. Increasing the productivity of land already under cultivation—through the use of high-yield plant varieties and better soil management techniques, for example—may help strike a balance between higher food production and conservation.

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 (or baseline) scenario.

For potatoes, for any given scenario, the projections vary greatly across climate models in terms of yield. Some results suggest that yields will increase by just 15 or 20 percent between 2010 and 2050, while other models suggest that yields will double during that time frame. However, there is agreement across all climate models and scenarios that the area under cultivation will increase by about 50 percent between 2010 and 2050. Together, the changes in yield and area result in a projected doubling or tripling of production from the current level. The projection for increased net exports of potatoes implies that, by 2050, Rwanda will be able to meet domestic demand for potatoes and have supplies left for export.

The results also indicate increased production, yield, and area under cultivation for sorghum, with yields doubling on average. There is variation between climate models for sorghum, though the variation is less than that for potatoes, with the high yields only 20 percent higher than the low yields. Although prices for sorghum will be roughly 25 percent higher by 2050, even in the pessimistic scenario per capita income will have doubled, making higher food prices easier to bear. For sorghum, we generally observe that exports will hold constant or increase, and in the few cases in which they decrease, the drop will be small.

Cassava is projected to increase in yield by about 60 percent between 2010 and 2050, though as for potatoes, the variance of predictions across climate models is large, with the high yield climate model resulting in 58 percent higher yields thatn the low yield model. Area under cultivation will increase by about 30 percent. This implies an approximate doubling in yield during the same timeframe. Global cassava prices are projected to rise by around 25 percent (averaging results for all scenarios and climate models together) over the period from 2010 to 2050.

In the baseline and optimistic scenarios, the IMPACT model predicts that the number of malnourished children will rise until 2015. Thereafter, it should decrease over the next 35 years. However, the pessimistic scenario predicts that the number of malnourished children will continue to rise for the next four decades. Although the absolute number of malnourished may rise, the malnutrition rate should remain virtually unchanged over the same period, owing to population growth. Under the optimistic scenario, greater per capita incomes will allow families easier access to food (increasing caloric availability), education, and health services, thereby lowering malnutrition rates.

Projections of available kilocalories per person are projected to increase moderately in the baseline scenario. However, in the pessimistic scenario, with much smaller growth in projected income, per capita kilocalories will likely decline, as relatively higher food prices negate the rise in incomes.

RECOMMENDATIONS

Among the recommendations advanced in the monograph from which this brief was drawn are the following. Policymakers should:

- support family planning to reduce fertility rates;
- expand the educational system beyond the primary level;
- reinforce the service sector;
- bolster the health system, adopt integrated pest management, and breed crop varieties suitable for warm temperatures to counter the spread of pests and disease;
- Invest in technology to raise the productivity of already-cultivated areas; and
- establish and improve institutions and infrastructure to coordinate and facilitate movement of foodstuffs and production inputs.

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