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East African Agriculture and Climate Change:

A COMPREHENSIVE ANALYSIS — ERITREA

BISSRAT GHEBRU[1], WOLDEAMLAK ARAIA[2], WOLDESELASSIE OGBAZGHI[3], MENGHISTEAB GEBRESELASSIE[4], TIMOTHY S. THOMAS[5]

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CURRENT CONDITIONS

Located in the Horn of Africa, Eritrea has a long coastline on the Red Sea. The country has varied topography, rainfall, and climate, with altitude ranging from 60 to more than 3,000 meters above sea level. The climate ranges from hot and arid near the Red Sea to subhumid in isolated micro catchments along the eastern escarpment. The central highlands have a semi-arid climate. Most of the year's rain falls within a short time, resulting in soil erosion and runoff.

Eritrea's total population is about 5.27 million people, of whom 50–60 percent live in highlands that comprise only about 10 percent of the country's total area. Life expectancy has increased modestly, from 40 years in the 1960s to about 52 years in 2010. The mortality rate for children under five years is decreasing, owing to improved mother- and child-care. Overall, malaria morbidity declined by more than 86 percent, and mortality due to malaria fell by more than 82 percent, making Eritrea one of the few Sub-Saharan countries to have met the targets for reducing malaria incidence set by the Abuja Declaration in 2000 .

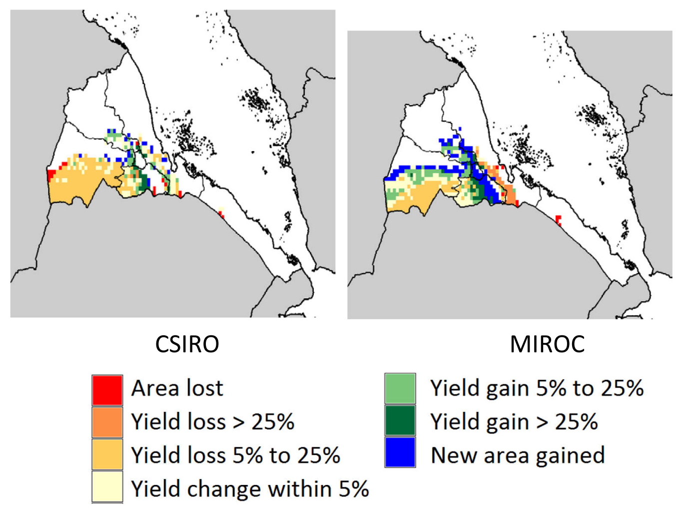
Agriculture is still an important sector for Eritrea, employing about half of the population and producing about 20 percent of GDP. Eritrea has several agricultural systems: rainfed cereal and pulses; semi-commercial and periurban agriculture; small-scale irrigated horticulture; commercial farming; agropastoral rainfed farming; and agropastoral spate irrigation systems. The major food crops grown in Eritrea are sorghum, millet and barley.

CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

As a basis for our analysis, we used four downscaled global climate models (GCMs) from the IPCC AR4. These models all projected temperature increases between 2000 and 2050, but there were significant variations between model results, as well as variations geographically. Of the four models, this extract focuses on just two. The CSIRO model projects a uniform increase of 1–1.5°C for the average daily maximum temperature for the warmest month. The MIROC model has similar results but projects a 0.5°C increase in the northernmost part of the country.

The CSIRO model shows no change in annual precipitation. However, the MIROC model shows areas of the Red Sea zone gaining 100–200 mm in precipitation. None of the four models shows a reduction in rainfall.

CHANGES IN YIELDS WITH CLIMATE CHANGE: RAINFED SORGHUM



The Decision Support System for Agrotechnology Transfer (DSSAT) crop modeling software was used to compute yields for six crops in rainfed and irrigated systems under current temperature and precipitation regimes, and then again for the 2050 climate projections. The maps above show the effects of climate change on rainfed sorghum. The MIROC map shows fairly large areas where sorghum production should become possible. Higher rainfall in the MIROC model may have influenced these changes. It could also be that, at higher elevations, temperatures are currently too cold for sorghum.

Both maps show areas of yield loss, with the CSIRO map showing larger areas of loss. These could be areas where heat is already a stress factor, and higher temperatures from climate change increased heat stress.

[1]National Board for Higher Education- Eritrea; [2]Hamelmalo Agricultural College-Eritrea; [3]University of Asmara-Eritrea; [4, 5]International Food Policy Research Institute (IFPRI).

Rainfed wheat has the potential for yield losses as high as 25 percent or more, with considerable loss of baseline crop area in some models. Wheat is a crop that is sensitive to heat, which explains why the losses are so substantial.

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.

Technological improvements in the agricultural sector were not factored into the crop model section of the analysis. The IMPACT model, however, does account for technological change.

The IMPACT model results for sorghum show a boost in the area of production and in yield. Looking at the median results for all scenarios, yield is projected to triple, and the area under production is projected to increase by roughly 50 percent, resulting in a quadrupling of production.

There is little difference in yield projections between various economic and demographic scenarios. There is, however, variation between the climate models, with the highest yield projection roughly 10 percent higher than the lowest yield projection for a given scenario.

The projections for sorghum trade have a high variance, making it more difficult to generalize about the results. Roughly speaking, however, the model suggests that, by 2050, imports of sorghum will be lower than in 2010 (except possibly under the pessimistic scenario). It appears that high population growth rates will cause consumer demand for sorghum to keep pace with even the most promising gains in production.

The IMPACT model projects wheat yields to double between 2010 and 2050. But with planted area increasing only slightly, production will no more than double. While wheat output will increase, consumer demand for wheat will increase even more, and production levels will not be enough to meet domestic demand, leading to a rise in imports.

The IMPACT model results in all scenarios have the number of malnourished children rising initially and then falling. For the optimistic scenario, the turning point is 2015; for the baseline, it is 2020; and for the pessimistic scenario, it is between 2025 and 2030. By 2050, only the pessimistic scenario predicts more malnourished children than in 2010. Even in this scenario, population growth causes the proportion of malnourished children to drop steadily.

In regard to average calorie consumption, the baseline and optimistic scenarios both project rising calorie consumption, with small initial annual increases that become significant increases by 2050. In the pessimistic scenario, average calorie consumption falls until 2025 and then begins to recover, ending slightly higher in 2050 than it started in 2010.

RECOMMENDATIONS

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

- introduce sustainable land management practices, including efficient water harvesting and water management strategies to cope with water scarcity and high runoff;
- support the construction of mechanical structures or terraces and the planting of trees to stabilize and reclaim degraded lands (sand dunes, gullies, and marginal lands);
- Introduce drought- and salinity-tolerant plant species in the major urban centers and rural communities along the coast;
- promote individual tree tenure to encourage widespread tree planting;
- consider energy-saving stoves to minimize tree-cutting for firewood and charcoal, and consider renewable sources of energy such as wind and solar;
- build capacity in climate modeling and remote sensing at the MSc and PhD levels, as well as early warning systems;
- ensure equitable land distribution and tenure over a long period for proper land management; and
- ensure that environmental plans in draft form are codified as coherent laws and regulations.

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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