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

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CURRENT CONDITIONS

The main crops in Ethiopia are teff, maize, and wheat. The population is about 79 million people. Life expectancy has been rising steadily, from less than 40 years in 1960 to about 55 years in 2008. Child mortality decreased gradually from about 270 cases per 1,000 births in 1960 to 210 cases per 1,000 births in 1980. The level remained constant through the 1990s and declined to 100 cases per 1,000 births by 2008. The combined effect of declining child mortality and increasing life expectancy has produced an overall population increase, putting additional pressure on the land to meet food requirements. More than 80 percent of Ethiopians live below the poverty line and are therefore vulnerable to small shocks and less able to recover from them.

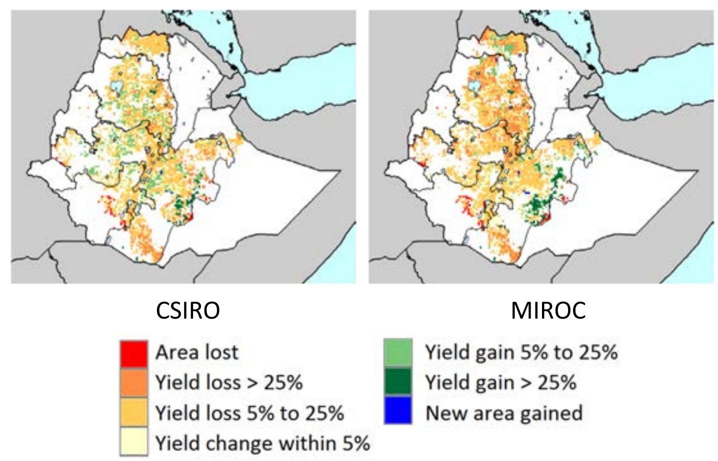
CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

Climate models often disagree, especially in regard to changes in precipitation. The CSIRO global climate model from the IPCC AR4 shows a decrease in annual precipitation in most highland areas of Ethiopia, while other models used in the analysis show normal to above-normal rainfall. MIROC shows a dramatic increase in precipitation over much of Ethiopia.

The MIROC and CSIRO models have similar results for changes in average daily maximum temperatures during the warmest month in 2050: while some areas would experience a temperature increase of 1.5–2°C, temperatures in most of the country would only rise by 1–1.5°C. The other two models in the report projected much larger Increases in temperature. Any temperature increase will increase rates of evapotranspiration, possibly leading to a deficit in the water balance and posing a major challenge to rainfed agriculture.

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 shown depict the results of climate change for rainfed wheat. The findings suggest substantial reduction in wheat yields and some loss of area, even where rainfall is expected to increase, presumably owing to heat stress. Wheat is the most lucrative crop and the third most important food crop by amount of consumption. This critical loss suggests a couple of option. The first would be more investment in heat-resistant wheat. This could perhaps be done in conjunction with international agricultural research institutes which specialize in wheat. Alternatively, research could be done in strategizing the best substitute crops to replace wheat. Furthermore, there may still be possibilities for wheat production in areas in which wheat had not previously thrived, as Ethiopia offers a wide range of diverse agroecologies.

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED WHEAT



We also used DSSAT to examine the impact of climate change on rainfed maize in Ethiopia. The CSIRO model suggested a gain in maize yields of more than 25 percent in the eastern highlands of the edge of Great Rift Valley as well as in the north-central highlands; to varying degrees, the model shows patches of new area gained along the eastern parts of Amhara and Tigray. But the results also reveal an equal amount of existing maize land that would be marginalized or completely unsuitable for maize, as well as a marked decrease in maize yield over the southwestern and eastern parts of central Ethiopia. The MIROC model suggested a considerable gain in maize production area, mainly in eastern Tigray.

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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 optimistic scenario shows GDP per capita exceeding US$1,000 by 2050. In the intermediate scenario it is about $700 in 2050. The pessimistic scenario shows stunted growth through 2050, which nonetheless results in a near doubling of 2010 per capita income.

IMPACT shows maize yield rising somewhat by 2020 and then leveling off. At the same time, it projects that cultivated area of maize would decline slightly after 2020. Together, this leads to production rising by around 25 percent to 2020 and then falling slightly thereafter (with levels in 2050 about the same as those in 2010). With no change in maize production, the rise in consumer demand from a growing population leads to imports of maize after 2020, despite the high world price for maize.

For wheat, the IMPACT results projected yields to more than double by 2050. While this appears to contradict the projections of the crop model, the IMPACT model factors in technological change. With a slight increase in area, production by 2050 increases to around 2.5 times the 2010 level. There were very little differences in yield projections across scenarios, and very little differences between climate models, suggesting that observed changes were driven by demand for wheat and by technological changes.

The IMPACT model projects that the number of malnourished children will decrease between 2010 and 2050 in the optimistic scenario, reflecting lower population growth and improvement in GDP; the baseline scenario showed a more or less constant number of malnourished children; and the pessimistic scenario showed an increase. Even though the absolute number increased in that scenario, the share of malnourished children declined owing to population growth.

Projections of available kilocalories per capita under multiple income and climate scenarios have clear increases under the optimistic scenario, modest increases under the baseline scenarios, and no increase under the pessimistic scenario.

RECOMMENDATIONS

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

- harmonize policies and institutional frameworks affecting climate change adaptation across different approaches and strategies;
- develop alternative adaptation options for the various plausible scenarios and design location-specific adaptation programs to reach all vulnerable populations;
- provide rural financing to promote adoption and utilization of proven technologies for climate-change adaptation;
- encourage risk-insurance institutions to insure rainfall risks, especially for smallholder farmers as they adopt improved agricultural production technologies to benefit from potentially increased rainfall;
- improve road infrastructure in remote areas to increase opportunities and access to markets and market information;
- manage rainwater to prevent potential flooding, water logging, erosion, and nutrient leaching under increased rainfall;
- integrate efficient agricultural water management practices with productivity-enhancing interventions;
- integrate indigenous strategies and complex local technical knowledge with science-based knowledge in order to support adaptation to climate change;
- promote new crop varieties adapted to drought, such as nutritionally enhanced maize varieties, as well as drought-tolerant sorghum, teff, cassava, and market-preferred common bean varieties[1]; and
- promote farming of dairy goats and poultry and the raising of silkworms in appropriate agroclimatic conditions

[1] Specific nutritionally enhanced crops—such as Quality Protein Maize varieties with high lysine and tryptophan content—could alleviate protein deficiency problems and under-five malnutrition, widely encountered in rural communities that depend on maize as their staple food.

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