# East African Agriculture and Climate Change:

## A COMPREHENSIVE ANALYSIS — KENYA

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## CURRENT CONDITIONS

Kenya is an ecologically diverse nation located on the Indian Ocean in eastern Africa. Most of the land is classified as arid or semi-arid, yet at higher elevations lush montane forests are found. Kenya is home to the second-highest peak in Africa, glacier-capped Mount Kenya.

Kenya has a population of 40 million people. The main crops are maize, tea, and potatoes. While the relative contribution of agriculture to GDP is declining, approximately 75 percent of the country's labor force is still engaged in farming. Along with the comparatively slow growth of real GDP per capita since 1980, this heavy engagement in agriculture makes climate change adaptation critical for Kenya's population over the next 30 or 40 years.

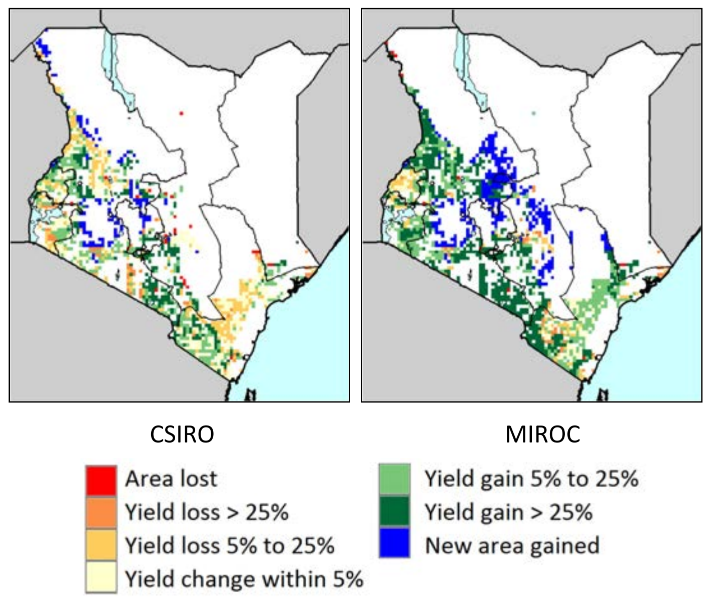
Life expectancy increased gradually from 1960 to about 55 years in 2008. The mortality rate for children under five years improved from the high of about 200 deaths per 1,000 in 1960 to approximately 130 deaths per 1,000 in 2008. In Rift Valley, Eastern, Nyanza, and the lower parts of Coast and Western provinces—where between 40 and 70 percent of the population live—most residents survive on less than US$2 a day.

## CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

Of the four downscaled global climate models (GCMs) used in our study, all of which are from the IPCC AR4, the MIROC model gives the most optimistic scenario, one in which nearly the entire country will experience an increase of 100–300 mm of precipitation between 2000 and 2050, with extreme northern Kenya and southwestern parts of the country gaining the most. The CSIRO-MK3 model predicts no change over the same period, except for a very moderate increase around Turkana District and in the southwest.

The CSIRO model predicts a fairly uniform temperature increase of 1–1.5$^0$C across the country for the average daily maximum during the warmest month. The MIROC model predicts that most medium- to high-potential agricultural areas will experience a marginal increase in temperature of only 0.5–1$^0$C, while the easternmost part of Eastern, all of North Eastern, and the southern parts of Coast Provinces will experience increases of 1–2$^0$C, which is likely to result in heat stress in some years for some crops.

### 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. There is a great deal of variation between models, and there is observable geographic variation within most models.

The climate change effects from both the CSIRO and MIROC models result in substantial yield increases in most areas, including large areas in which the increase is projected to be greater than 25 percent, especially for the MIROC GCM. All models predict yield gain in areas that were previously too dry for maize cultivation. With these new areas becoming available, it would seem important for policymakers to consider facilitating expansion or relocation in some newly viable areas, while taking into account their ecological

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importance. Climate change may force farmers to abandon some areas that they are currently cultivating in favor of new areas with the potential for maize production. Changes in laws and procedures might be needed in advance to facilitate such movement.

## 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 pessimistic scenario has very slow growth in per capita GDP, increasing by just under 50 percent between 2010 and 2050 to US$543. The baseline and optimistic scenarios predict a much brighter future, with increases of nearly 400 percent and 700 percent, respectively.

The IMPACT model predicts a gradual upward trend in maize production under all three scenarios. This production increase is largely due to increases in yield: the area under maize production remains mostly unchanged from 2010 to 2050, while yield nearly doubles. The world price for maize is projected to roughly double over that period.

In the case of maize, by 2050, yield predictions differ across climate models by about one-third from the lowest projection to the highest projection in each of the economic and demographic scenarios, while the variation in yield between scenarios is very small. On the other hand, economic scenarios are the largest driver of consumer demand for maize.

Under the pessimistic scenario, the number of malnourished children under five years of age increases to 1.7 million by 2015 and then gradually rises to a peak of 1.8 million in 2050. Under the intermediate scenario, the number will increase from 1.5 million to a peak of 1.6 million, before declining over time to 0.8 million by 2050. Under the optimistic scenario, the number decreases from a 1.5 million in 2010 to 0.5 million by 2050. The *share* of malnourished children declines steadily because of population growth.

A look at trends in available kilocalories per capita shows a slow downward trend under the pessimistic scenario. Available kilocalories decline from high of 1,950 in 2010 to a low of 1,650 in 2050. During this period, in the pessimistic scenario, the main staple, maize, almost doubles in price, while income rises less than 50 percent. Looking at both the optimistic and baseline scenarios, mean calorie consumption rises slowly for the first 20 years, after which it assumes a relatively rapid upward trend up to 2050.

## RECOMMENDATIONS

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

- ensure coordinated implementation of climate-change mitigation and adaptation activities in all economic sectors;
- stimulate broad-based growth by ensuring educational opportunities (for adult learning as well as secondary education for girls), and improving the business environment so that manufacturing and service industries can thrive;
- encourage family planning to slow the population growth rate;
- invest in infrastructure to ensure that farmers have access to inputs at the lowest possible market prices and can sell their outputs at the highest possible prices;
- consider irrigation potential as an adaptive intervention against adverse effects of climate change; and
- educate primary and secondary schoolchildren about climate change adaptation in the agricultural sector.

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