West African Agriculture and Climate Change:
A COMPREHENSIVE ANALYSIS — GUINEA

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CURRENT CONDITIONS

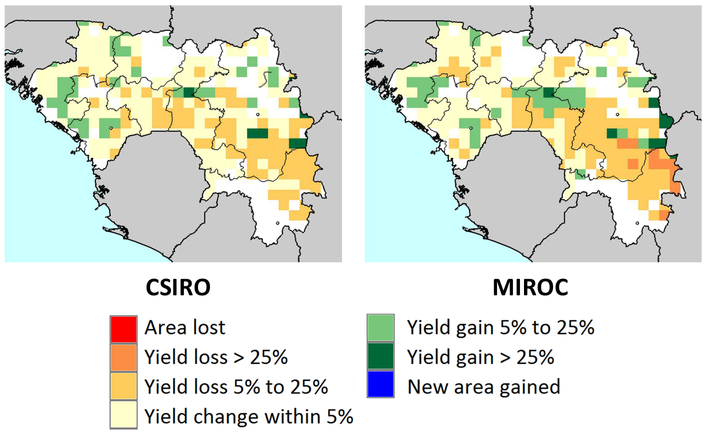
Guinea has a tropical climate with two alternating seasons, a November–March dry season and an April–October rainy season. In general, rainfall increases from north to south. Average annual rainfall is 1,988 mm. Rice is the staple crop, and other important food crops are corn, fonio groundnuts, and cassava. Most of the population is rural, and the agricultural sector is the major employer. Urbanization is a growing phenomenon in Guinea. Agricultural GDP remained at about 20 percent of total GDP between the mid-1980s and 2005. By 2009, that share declined to less than 10 percent, reflecting a stagnation in agricultural productivity and the growth of other sectors like mining and the service sector.

Infant mortality has decreased, and life expectancy has increased. The improvement in these indicators may be attributed to improved health conditions, particularly vaccination of children, as well as the benefits of economic liberalization. Malnutrition among children under five years is high (22.5 percent in 2005), and 80-90 percent of Guinea's population lives on less than US$2 a day. The population is expected to double by 2040–2050. In addition to increasing demand for social services (health, education, water supply, electricity, and related infrastructure), growth will put pressure on agricultural land, which will result in a further reduction in the fallow period, decreasing yields, unless compensated for in some other way.

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. The models show a diversity regarding changes in annual rainfall between 2000 and 2050, though there are a lot of similarities between the CSIRO GCM and the ECHAM GCM. They both predict rainfall reductions of 50–100 mm in large areas of central and northern Guinea. Only the MIROC model predicts a substantial decrease (200–400 mm) in the forest region. However, both the CNRM and MIROC models predict an increase of 50 –100 mm in the Boke and Kindia regions (the CNRM model projects wetter areas than the MIROC model, ranging up to 130 mm).

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED MAIZE



All the models predict that temperatures will rise by at least 1–1.5^{0}C in every part of the country for the average daily maximum during the warmest month. However, the CNRM and ECHAM models project relatively higher temperatures, with the CNRM having areas with increases up to 2.5^{0}C and the ECHAM showing areas with increases as high as 2.8^{0}C. The CSIRO or MIROC models have maximum increases in temperature in Guinea of 1.4^{0}C and 1.7^{0}C, respectively. The combination of increased temperatures and lower rainfall would have adverse effects on water availability and thus on agricultural production.

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. The CSIRO and MIROC models predict change in yield losses of 5–25 percent for much of the country. The MIROC model predicts a yield reduction greater than 25 percent in the southern border areas of N'Zérékoré and Kankan. Yet both also have a few areas where yield is projected to increase.

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For rice, the MIROC model projects a mix of yield gain and yield loss. The CSIRO model projects yield gains more consistently, most of which are 5–25 percent.

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.

In the pessimistic scenario, per capita GDP will double between 2010 and 2050. In the intermediate scenario, it will quadruple, and in the optimistic scenario, it will increase by almost 600 percent. Much effort will be needed to make progress towards the optimistic scenario, including policies relating to family planning education and increased economic investment.

Under all scenarios, rice yields are expected to increase from about 0.8 metric tons (MT) per hectare (ha) to 1.3 MT/ha between 2010 and 2050, when averaged across all scenarios and the four climate models. For rice in Guinea, the climate models have almost identical yields, while there is perhaps a 0.1 MT/ha difference between the pessimistic scenario and the optimistic scenario in 2050. Harvested area is virtually unchanged. Total production of rice increases by around 60 percent. Net imports would continue to increase under all the scenarios, as population growth and income growth increases domestic demand by a greater margin than the rate of production increase.

For cassava, IMPACT projects yield growth of 46 percent, on average, between 2010 and 2050. Variation between climate model yields shows the high to be about 15 percent more than the low. Area grows by around 16 percent, and therefore total production grows by almost 70 percent, which fall short of meeting domestic demand.

Maize yield is projected to rise by 92 percent between 2010 and 2050. The differences in yield predictions from various climate models is minimal, with the high yield 6 percent higher than the low yield. Harvested area is projected to increase by almost 20 percent. Total production rises by 127 percent. Unlike the cases of rice and cassava, maize exports are expected to increase.

The yield projections for maize from the IMPACT model are very different than the projections from the DSSAT crop model. The main reason for the difference is that the IMPACT model allows for adaptation and technological improvements, and the crop model does not.

Millet yields are projected to dramatically increase, rising by 220 percent between 2010 and 2050. Harvested area actually declines by 2050, but total production roughly triples. IMPACT suggests that millet demand will grow even faster, leading to net imports of millet.

In the baseline and optimistic scenarios, the number of malnourished children under five years will decrease after 2020. In the pessimistic scenario, however, that number is projected to increase through 2035 and then remain constant through 2050. Accounting for population growth, however, the proportion of malnourished children should decline under all scenarios.

In the baseline and optimistic scenarios, the availability of kilocalories per capita will rise. In the pessimistic scenario, it will decrease.

RECOMMENDATIONS

Among the recommendations advanced in the monograph from which this brief was drawn are that policymakers should:

- protect natural habitats from degradation due to agricultural expansion as a result of population growth and climate change.
- bolster the meteorological department to better monitor climate and predict weather patterns; and
- support agricultural research and extension to develop resilient crop varieties (particularly for rice, maize and groundnut) and to improve yields. The research system should also determine appropriate management practices like time of planting, crop densities and mixtures for improved productivity.

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