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

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CURRENT CONDITIONS

The Republic of Benin experiences transitional tropical conditions with less rainfall than is seen in other areas of the same latitude. The rainy season runs from mid-April until October. The major staple food crops are yams, cassava, and maize, and the major cash crops are seed cotton and cashew nuts. The malnutrition rate for children under five years is high (21.5 percent in 2001), but the mortality rate for children under five years has decreased by half since the late 1960s, a result of a national food security program, as well as health programs addressing malaria, AIDS, poliomyelitis, and child healthcare. However, with population projected to at least double (to 18–25 million people) by 2050, Benin's natural resources base and food supply are under threat.

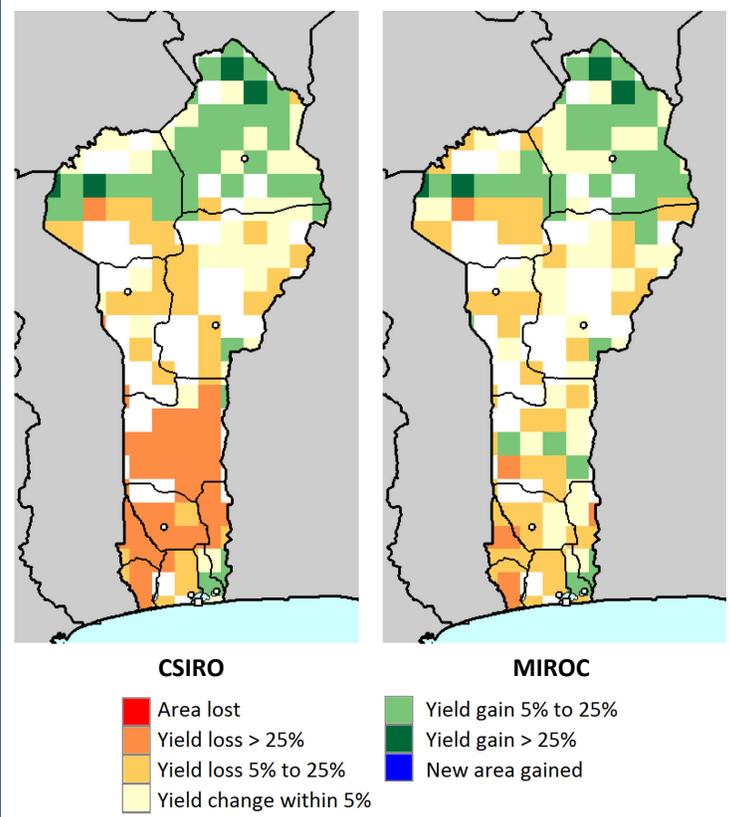## CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

The research used four downscaled global climate models (GCMs) from the IPCC AR4. The models differ in their projections for annual precipitation changes between 2000 and 2050. The CNRM GCM predicts no change in rainfall over almost the entire country, with only the northern most part with a rainfall increase of between 50 and 100 mm. The CSIRO model projects the driest future for Benin, with the southern have projected to have rainfall decrease between 100 and 200 mm, followed by a band from the center to about 80 percent of the way north predicting a decrease of 50 to 100 mm, and then the remainder in the north not predicted to change significantly.

The MIROC GCM has the most geographic variation for rainfall of the four models. Like the CSIRO model, it starts with a coastal band of precipitation decline of 100 to 200 mm. However, the rainfall progressively improves and gets wetter, so that the very northern part of the country has an increase of 100 to 200 mm of rain, with bands in between the south and north of a 50 to 100 mm decline; no significant change; and a 50 to 100 mm increase.

One concern about higher rainfall is that livestock production that is adapted to the relatively drier northern region could also be affected by increased incidence of pests and diseases due to wetter conditions.

The MIROC model predicts the lowest temperature change of the four models. Temperatures range from 1.3-1.5^{0}C over the

CHANGES IN YIELD WITH UNDER CLIMATE CHANGE: RAINFED MAIZE

CSIRO   MIROC

Area lost
Yield loss > 25%
Yield loss 5% to 25%
Yield change within 5%
Yield gain 5% to 25%
Yield gain > 25%
New area gained

entire country. The CSIRO model is the second most moderate model for temperature rise, with temperatures rising 1.4-1.7^{0}C. ECHAM and CNRM GCMs have median temperature increases projected to be 2^{0}C and 2.1^{0}C, respectively.

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

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2050 with climate change to yields with 2000 climate. The data indicate a slight yield increase of 5–25 percent in the north. For the central and the southern parts of the country (covering the most productive zone of maize), the MIROC models shows mostly yield reductions of 5–25 percent. The CSIRO model predicts even greater reduction in maize yields, exceeding 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.

According to both the optimistic and baseline scenarios, GDP per capita is projected to improve, with the baseline scenario projecting a 275 percent increase between 2010 and 2050, and the optimistic scenario with more than a 500 percent increase. According to the pessimistic scenario, however, per capita GDP will actually decline to about half the 2010 value by 2050.

IMPACT projects that maize yield will rise by almost 90 percent when averaged across all scenarios and the four climate models. While yields seem to be the same across scenarios, the climate models give differing yield predictions, with the highest 8 percent higher than the lowest. Maize area should increase slightly, by approximately 20 percent. Together, they suggest that total production should grow by 125 percent.

Projected net export levels differ across the scenarios. In the baseline and optimistic scenarios, the export of maize is expected to rise steadily. In the pessimistic scenario exports increase modestly initially and then decrease to just above the current level. This trend can be explained by the projected increase in population, and hence increased domestic consumption. The results from the food prices analysis suggest an increase for maize by 101 percent between 2010 and 2050, when averaged across the three scenarios and four climate models.

For yams and sweet potatoes, yield increases by 85 percent between 2010 and 2050, though there is a 30 percent difference between the low-yield climate model and the high-yield climate model. Harvested area is projected to decline by 10 percent, leading to a 66 percent increase in production. Net imports increase slightly.

The cassava yield is expected to rise by 30 percent, though there is great variation between the yields from the different climate models, with the highest being 32 percent greater than the lowest. Net imports of cassava and other roots/tubers will increase significantly.

Under the baseline scenario, the number of malnourished children under the age of five increases slightly; in the pessimistic scenario, the number almost doubles by 2050; under the optimistic scenario, the number of malnourished children in Benin would continue to increase slightly until 2030 and then decline by 2050 to slightly less than the 2010 level. With rapid population growth, we expect that the proportion of malnourished children would be lower in 2050 than in 2010 for all but the pessimistic scenario.

Average calorie consumption is predicted to decrease slightly under the baseline scenario and significantly under the pessimistic scenario. Under the optimistic scenario, a significant increase is projected after 2030.

RECOMMENDATIONS

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

- monitor climate and provide relevant information for early warning for adverse consequences;
- support agricultural research efforts aimed at developing and identifying crop varieties that could be more adaptive to climate change;
- establish social safety nets for poor farmers;
- promote the development and adoption of more efficient water-use techniques;
- support capacity-building of farmers by ensuring access to climate information; and