West African Agriculture and Climate Change:

A COMPREHENSIVE ANALYSIS — CÔTE D'IVOIRE

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CURRENT CONDITIONS

Côte d'Ivoire enjoys a humid climate, with at least seven rainy months and 1,000 mm in annual rainfall. Most of the interior receives 1,000–1,500 mm annually. Moving inland toward the east, a short dry season falls in the middle of the wet season, creating an annual cycle of four seasons. Cocoa is the major cash crop. Yams, cassava, and plantains are the major staples. The contribution of agriculture to GDP declined steadily between 1960 and 1980 as the manufacturing and service sectors improved.

The population has doubled every 20 years since the country gained independence in 1960. In 2008, almost half of the population lived in urban areas. The majority of the population is engaged in agriculture. After independence, life expectancy at birth increased from 40 years to 55 years by the late 1970s. The mortality rate for children under five years decreased dramatically from 300 deaths per 1,000 births in the 1960s to less than 200 deaths per 1,000 births in 1980, reaching 125 deaths per 1,000 births in 2008. The under-five malnutrition rate, estimated at 16.7 percent in 2006, is lower than most countries in the region.

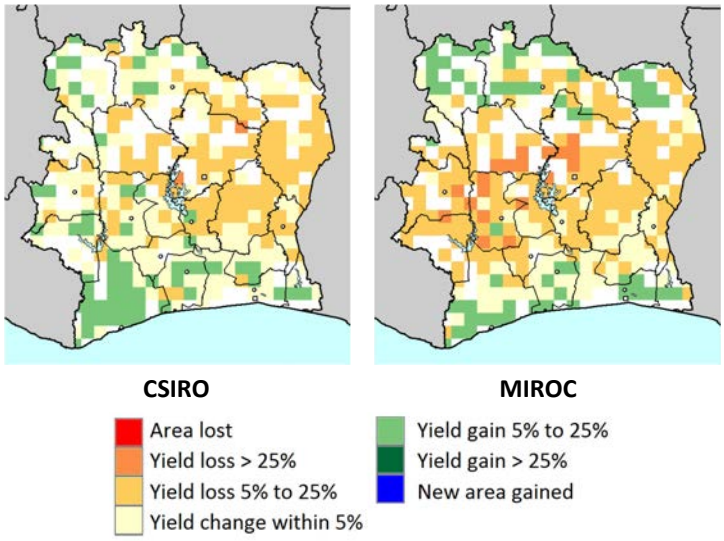
The legacy of a decade-long civil war and the projected doubling of the population by 2040–2050 complicate the government's ability to rebuild the country and to sustainably manage its natural resource base.

CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

We used four downscaled global climate models (GCMs) from the IPCC AR4. The models differ in their projection of annual rainfall changes between 2000 and 2050. The CNRM GCM shows an increase in precipitation of 50 to 100 mm in the north and on the coast; ECHAM shows a similar increase in the southwest. The CSIRO GCM shows a decrease in precipitation of 100 to 200 mm in the northern half of the country, while MIROC3.2 shows a decrease of up to 400 mm in the southwest and a decrease of 100 to 200 mm in the southeast.

The CNRM model predicts a temperature increase of 2–2.5^{0}C across the country for the average daily maximum during the warmest month. The ECHAM model predicts an equivalent increase in the north, but it projects a rise of only 1.5–2^{0}C in the southern half of the country. The results of the CSIRO model mirror the geographical distribution projected by the ECHAM model, but CSIRO predicts temperatures a half degree cooler across the board. The MIROC model projects the smallest increase, with maximum temperature rising by only 1–1.5^{0}C, as well as a substantial area in the center and east where temperatures will increase by only 0.5–1^{0}C.

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED RICE



The maps above depict the results of the Decision Support System for Agrotechnology Transfer (DSSAT) crop modeling software projections for rainfed rice, comparing crop yields for 2050 with climate change to yields with 2000 climate. The CSIRO model predicts a yield increase of 5–25 percent, primarily in the southwest, and a yield loss of 5–25 percent in the east. In contrast, the MIROC model projects scattered yield gains in some parts of the north and south, yield losses of more than 25 percent in the central region, and losses of 5–25 percent to the east and west.

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For maize yields, the ECHAM model predicts that most of the northwest will experience losses of more than 25 percent, with most of the rest of the country with yield losses of 5 to 25 percent. MIROC predicts a similar outcome. The CNRM model predicts gains and losses in equal measure across the country. The CSIRO model falls somewhere between the CNRM and the MIROC, with very few gains projected

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.

In the pessimistic scenario, per capita GDP rises by 66 percent between 2010 and 2050, while the intermediate scenario rises by 385 percent and the optimistic scenario rises by 700 percent.

Averaging across the IMPACT projections for the three scenarios and four climate models, rice yield will increase by 43 percent between 2010 and 2050. Yields in the optimistic scenario are approximately 2 percent lower than yields in the pessimistic scenario, while given a scenario, the highest yield among the four climate models is roughly 10 percent higher than the lowest yield.

The yield projections are very different than those given by the crop model. That is because IMPACT allows for adaptation and technological advancement, while the analysis using DSSAT kept these things fixed.

IMPACT results show that rice area expands by roughly 12 percent between 2010 and 2050, which, when coupled with yield projections results in total production expanding by 60 percent. This is insufficient to keep pace with increased demand from a larger population with greater income. While net exports are estimated to shrink under all scenarios, the decrease is greater in the optimistic than the pessimistic scenario.

On average, yield for sweet potatoes/yams will only increase by 11 percent, which is considerably smaller than for rice. The differences in yield predictions for different climate models is much greater than for maize. The difference between the highest and lowest is 27 percent. Harvested area is expected to decline slightly, by 8 percent. Production will rise ever so slightly between 2010 and 2050. Net imports are projected to increase progressively, despite the increase in world prices.

Cassava behaves very similar to sweet potatoes and yams in regard to yield changes: relatively small yield increase, with large differences in yields between climate models. Harvested area will rise slightly, with total production growing by 34 percent.

The estimates for the number of malnourished children under the age of five will decrease in the baseline and optimistic scenarios, but increase very gradually in the pessimistic scenario. Since population is growing, the gradual rise in the number of malnourished children would reflect a decline in proportion of malnourished children.

The pessimistic scenario projects a decrease in available kilocalories per capita from. The optimistic scenario projects a large increase. Both of these reflect income effects, with the price effect of higher food prices outweighing gain in income for the pessimistic scenario.

RECOMMENDATIONS

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

- improve recording of daily weather data and seasonal forecasting;
- improve communication networks and market infrastructure, including appropriate storage facilities and rural roads to facilitate easy transport and storage of produce;
- fund agricultural research and extension to develop productivity-enhancing technologies/management practices;
- consider incentives to enhance private and NGO sector participation in their development and distribution;
- develop crop varieties, particularly of maize, that are resilient to climate change;
- support family planning and other interventions to slow population growth;
- consider climate change mitigating policies like reforestation, soil organic carbon augmenting practices, and modified livestock management practices.

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