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West African Agriculture and Climate Change:

A COMPREHENSIVE ANALYSIS — BURKINA FASO

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CURRENT CONDITIONS

Agriculture is mainly rainfed in Burkina Faso and dominated by small-scale farmers. The rainy season is May–October, but its duration decreases progressively from the southwest, resulting in only three months of rainfall in the north. Agriculture accounts for 40 percent of GDP and 60 percent of the country's total exports. Sorghum and millet are the major staples, while cotton is the major cash crop. The percentage of the population in cities rose sharply in the mid-1970s, partly as a result of the 1972–1973 drought that pushed out many farm families. The share of GDP from agriculture has generally been 30–40 percent, declining between 1960 and the early 1980s and then again after 2000.

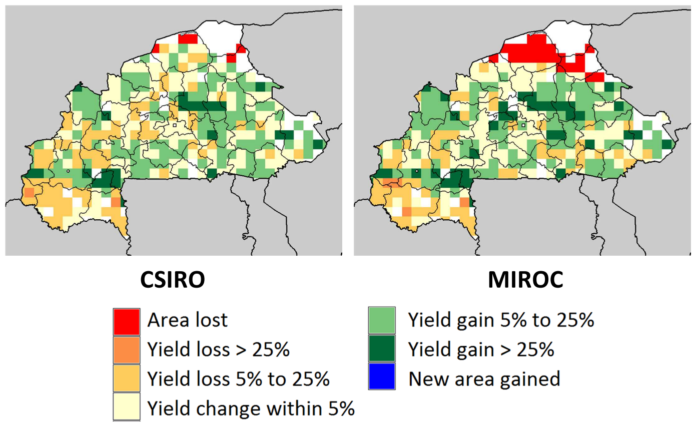
Life expectancy increased from less than 40 years in 1960 to 53 years in 2008. The mortality rate for children under five years decreased from more than 300 deaths per 1,000 births in 1960 to less than 200 deaths per 1,000 births in the mid-1990s, largely because of vaccination against childhood diseases. The malnutrition rate for children under five years remains high (35.2% in 2003). The population is projected to more than double by 2050, which will put severe pressure on the natural resource base and on public and social services.

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 CNRM and MIROC models project an increase in annual rainfall in large areas of the country, with the MIROC model having a larger area of increase of the two, and with a median increase of 125 mm. However, the CSIRO model predicts a decrease in rainfall of 100–200 mm in the center and southwest (with no change in the north and east), while the ECHAM model predicts no significant change in any location.

The CNRM and ECHAM models predict an increase of 2–2.5^{0}C in the average daily maximum temperature during the warmest month, while the CSIRO model predicts an increase of 1.5–2^{0}C over the entire country, and the MIROC model predicts a 1–1.5^{0}C over the central and southern part, and a half degree higher in the northern-most part. Temperature increases in the tropics generally lead to a reduction in crop yields and production. Most of the cereal crops grown in Burkina Faso can withstand temperature increases if sufficient water is available. However, with the lack of irrigation infrastructure, crop yields will likely decrease.

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. Climate change from both models project maize yield rising by 5–25 percent over a substantial part of the country. In some areas, yield will increase by more than 25 percent. However, the models also indicate a reduction in maize yields in some areas where maize is currently grown. We note some yield increases in the CSIRO model where annual rainfall is projected to decline. However, the crop model only cares about rainfall during the growing months, so yield increases likely reflect increased rainfall during those months.

For sorghum, there is agreement across models that yields will decline by 5–25 percent. The ECHAM and MIROC models project yield loss greater than 25 percent, particularly the central and southwestern regions. All models suggest a general loss of

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harvested area in the north. The largest yield loss is more than 25 percent, based on the ECHAM model projections.

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.

The pessimistic scenario projects little growth in per capita GDP until after 2025, after which the growth accelerates, leading to a 180 percent increase between 2010 and 2050. While the optimistic scenario predicts a rapid increase in per capita GDP (growing almost seven times as large in 2050 than it was in 2010), this is highly unlikely without the discovery of new mineral resources.

IMPACT projects maize yields to rise by 70 percent, on average between 2010 and 2050. However, while the differences between the yields of different scenarios is negligible, the difference between the yields for the best climate and worst climate out of the 4 we used is about 17 percent. Harvested area will decline slightly, resulting in total production expanding by around 60 percent. With the rise in consumer demand from population growth and income effects, net exports will decline between 2010 and 2050.

The reason yield increases for maize are much higher in the IMPACT model than in the crop model is that IMPACT allowed for adaptation and technological change, while the crop model held everything constant.

Sorghum yield is projected to rise by 95 percent between 2010 and 2050, averaging the results for all scenarios and climate models. The difference between the low yield climate and the high yield climate is approximately 10 percent. Harvested area is projected to increase by 23 percent. Production will rise by more than 130 percent.

Millet yield almost triples between 2010 and 2050, with about a 9 percent difference between the highest yield from the climate models and the lowest yield, and a 2 percent difference between the yield for the pessimistic scenario and the optimistic scenario. Area rises by around 25 percent, leading to a 260 percent increase in production, enough to increase the net exports. Unlike the other grains, world millet prices actually decline from 2010 and 2050, while net exports of millet by Burkina Faso rise.

Cotton yield rises by around 90 percent on average, while cotton area rises by 60 percent, leading to production rising by 200 percent, and net exports growing rapidly. Trends for cotton are similar in all the scenarios and comparable to those for millet. Burkina Faso recently adopted highly productive GMO cotton, supporting the plausibility of the production and yield trends.

The world price for maize is expected to increase by 101 percent between 2010 and 2050, averaged across all scenarios and climate models. The price of cotton is projected to rise by 68 percent, while sorghum prices will rise by 25 percent.

In all scenarios, the number of malnourished children under five years will increase, at least until 2025. Only in the optimistic scenario is the number projected to be lower in 2050 than in 2010. While the number of malnourished children is projected to increase under the baseline and pessimistic scenarios, it is likely that the proportion of children who are malnourished will decline under all scenarios, due to the projected considerable population increase.

In the pessimistic scenario, available kilocalories per capita decline slightly until 2025 and then rise to a level slightly higher than the at present by 2050. The other scenarios, however, paint a much brighter future. The optimistic scenario projects the largest increase, which explains the decrease in the number of malnourished children.

RECOMMENDATIONS

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

- build the capacity of farmers to more efficiently manage crops;
- control surface water and groundwater to manage supply during dry seasons and spells;
- ensure enough water, fertilizers, pesticides, and other inputs for garden market crops; and
- promote field water harvesting technologies (such as zai[5] combined with stony lines, half moons , mulching, etc.) to control runoff/erosion that contributes to land degradation.

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