West African Agriculture and Climate Change:
A COMPREHENSIVE ANALYSIS — SIERRA LEONE

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CURRENT CONDITIONS

Agriculture is the largest sector in the Sierra Leone economy, employing more than 75 percent of labor force and contributing between 35 and 47 percent of GDP. Rice, the staple food crop, is grown mainly by small-scale farmers under rainfed conditions. Transporting produce remains a challenge, as most of the roads in remote areas are impassable during the rainy season.

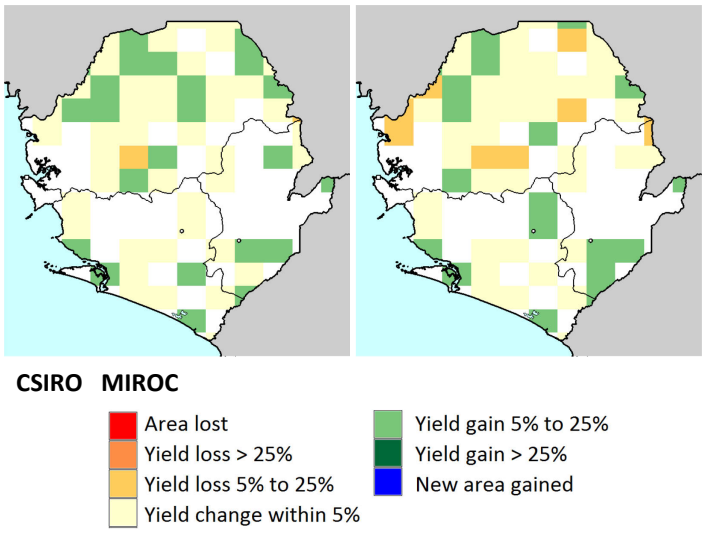
Sierra Leone has one of the highest mortality rates in sub-Saharan Africa. The mortality rate for children under five years is the highest on the continent at 297 deaths per 1,000 births for males and 271 deaths per 1,000 births for females. Life expectancy is still low (48.4 years, according to the 2004 census). The malnutrition rate among children under five years is one of the region's highest (estimated at 27.2 percent in 2003). Some 70–80 percent of the population lives on less than $US2 a day.

CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

We used four downscaled global climate models (GCMs) from the IPCC AR4. Three of the models were in reasonable agreement regarding changes in annual rainfall by 2050. The CNRM, CSIRO, and ECHAM models project mostly no change in annual precipitation for most of the country, with an increase of 50–100 mm in perhaps one-fifth of the country. The CNRM model predicts a 50–100 mm increase in the northwestern region. The CSIRO model predicts similar results in the south and part of the west, while the ECHAM model predicts similar results in parts of the northwestern and southwestern regions. In contrast to those three GCMs, the MIROC model predicts a reduction in rainfall in all parts of the country except the northwest, averaging perhaps 100 mm.

The CNRM model predicts an increase in the average daily maximum temperature during the warmest month of 2–2.5^{0}C across the country, except for a small portion that is mainly in the coastal area. The CSIRO and MIROC models predict increases of 1–1.5^{0}C. However, the ECHAM model projects that the increase will be greatest in the north and northeast (with a maximum increase of 2–2.5^{0}C).

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED RICE



The maps above depict 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. Both the CSIRO and MIROC models project that rainfed rice will do moderately well with climate change, with yield gains of 5–25 percent in areas throughout the country, and few areas with projected losses.

For groundnuts, the yield is projected to decline by 5–25 percent in many areas (CSIRO and MIROC predict only modest losses, while the results of the ECHAM model are more severe).

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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 (baseline) scenario.

In the pessimistic scenario, per capita GDP barely reaches $400 by 2050. In the baseline scenario, it increases to $1,400. In the optimistic scenario, it reaches $2,500.

IMPACT projects that rice yield will increase by close to two-thirds between 2010 and 2050. On average, the pessimistic scenario has a 5 percent higher yield than the optimistic scenario, and within each scenario, the climate model with the highest yield is roughly 5 percent higher than the model with the lowest yield.

By 2050, rice area is projected to grow by around 15 percent, though the growth is a few percentage points higher for the pessimistic scenario, and a few percentage points lower for the optimistic scenario. The climate models do not seem to make any difference in area projections.

Yield and area together suggest that production will grow by close to 90 percent, with the pessimistic scenario having about 10 percent higher production than the optimistic scenario. Even with such growth, the growth in consumer demand, brought about by a rapidly growing population and a higher income for the population, results in an increase in rice imports, especially in the optimistic scenario.

For cassava, the IMPACT model projects an increase in yield of around 75 percent, but only an area increase of 4 percent, resulting in a production increase of 80 percent. Net trade in cassava is relatively flat between 2010 and 2050, with a slight increase in net exports up to 2030, and a slight decline thereafter.

For groundnuts, yield is not projected to increase. All production increase come from increases in harvested area, which are projected to be around 25 percent for the optimistic scenario, with the pessimistic scenario being around 3 points higher and the optimistic scenario being around 3 points lower. Net exports decline after 2030, after holding steady prior to that.

The pessimistic scenario predicts an increase in the number of malnourished children under five until 2040, at which time it levels off. While all scenarios include at least some years in which the absolute number of malnourished children is projected to rise, once the population growth rate is factored in, we find that the share of malnourished children will likely decline under all scenarios, when comparing 2010 and 2050.

The optimistic scenario predicts a larger increase in available kilocalories per capita than the baseline scenario. The pessimistic scenario predicts a decrease through 2030 and then an increase (although by 2050, there will be fewer available than in 2010). The data suggest that increased availability of kilocalories is correlated inversely with the number of malnourished children. It also suggests that the rise in food prices counteracts the positive gains of rising incomes, if the incomes rise too slowly.

RECOMMENDATIONS

Policymakers should consider the following actions:

- expand the number and capacity of weather stations countrywide to provide farmers with reliable weather data;
- support to the Sierra Leone Agricultural Research Institute and the Njala University to improve crop varieties and practices;
- develop seed banks (or join international efforts to do so);
- build feeder roads in rural areas that can withstand higher rainfall;
- limit population growth and rapid urbanization (through development of infrastructure, social services, and agricultural mechanization in rural areas);
- Improve irrigation efficiency and promote public awareness of climate change, water storage, and management; and
- support agricultural research system to develop short-duration crop varieties, particularly groundnut, that can adapt to drier or wetter conditions as indicated by results of this study.

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