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Southern African Agriculture and Climate Change:
A COMPREHENSIVE ANALYSIS — ZIMBABWE

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CURRENT CONDITIONS

Zimbabwe has a subtropical climate with a summer season extending from October to April. Rainfall is erratic and unevenly distributed, resulting in crop failures that occur three out of every five years. Semi-arid conditions cover 75 percent of Zimbabwe. Smallholder farmers in these areas currently face food insecurity as a result of climate variations.

The percentage of GDP from agriculture has fluctuated between 10 and 20 percent, reaching its lowest shares during dry years (in 1991–92, 1992–93, and 2001–02). Between 2000 and 2008, the urban growth rate declined to 1.2 percent, while rural growth became negative (–0.7 percent). The growth in the number of people living in cities reflects migration from rural areas during the 1980s.

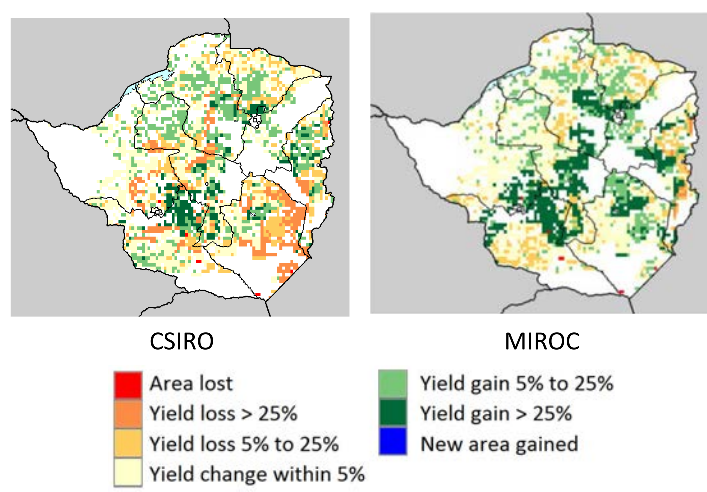
CLIMATE CHANGE SCENARIOS & THEIR POTENTIAL EFFECTS ON YIELDS

Of the four downscaled global climate models (GCMs) used in our study, all of which are from the IPCC AR4, CSIRO and MIROC predicted annual precipitation increasing in the extreme northern region, with little change in the rest of the country. Another model predicted that rainfall would decrease by 100–200 mm over most of the country.

The research also analyzed changes in the peak temperature for the month with the highest average daily maximum. The CSIRO and MIROC models predicted an overall increase in the annual maximum temperature. Both models also depicted temperature increases of 1.5–2ºC for all but the northernmost regions of the country. One of the other models, however, shows increases of 2.5–3ºC for the majority of the country and 3–3.5ºC for the western region. Such high changes, coupled with predicted decreases in rainfall, could adversely affect some crops.

The maps 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. In addition to temperature and precipitation, we also factored in soil data, assumptions about fertilizer use and planting month, and additional climate data.

CHANGES IN YIELD WITH CLIMATE CHANGE: RAINFED MAIZE



The results indicate that yields will increase in some important areas by more than 25 percent over the baseline in most maize-producing regions. In some other areas, yields will decline (mostly by 5–25 percent), and scattered parts of the baseline area will be lost. The CSIRO results show areas in the south where yield loss may be greater than 25 percent. Despite the increase in precipitation that the CSIRO and MIROC models foresee, DSSAT predicts yield losses in northern Zimbabwe.

In regard to the impact of climate change on sorghum, the CSIRO and MIROC models project yield losses for almost the entire country. The results indicate that maize tolerates higher temperatures better than sorghum does. However, another recent study found that sorghum proved more resilient to the effects of climate change than maize, groundnuts, or pigeon pea. This suggests that additional research may need to be done to reconcile the difference between the two studies.

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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, a pessimistic scenario with low per capita income growth, and an intermediate (or baseline) scenario.

While there is little difference between the GDP per capita projections for the baseline and pessimistic scenarios, these differ greatly from those of the optimistic scenario, which increases by more than five-fold between 2010 and 2050 (which is the least probable judging from past performance).

The IMPACT model suggests that maize yield will more than double between 2010 and 2050 under all scenarios and climate models, while harvested area will increase gradually until 2025 before decreasing to its initial level. Production will double over that timeframe.

There is very little difference in mean yields between scenarios, and only 10 to 12 percent difference between the lowest yield of the climate models and the highest yield, for any scenario.

Cotton yields are expected to triple, and harvested area is expected to increase by 25 percent, nearly quadrupling production. Since domestic use of cotton is limited, the results suggest an increase in net exports.

Unlike the case for maize, projected cotton yields vary by 25 percent between the climate model with the lowest yield and the one with the highest yield. No differences appeared to exist between scenarios.

The data suggest that sorghum and millet yields will rise dramatically, with sorghum tripling and millet quadrupling. The harvested area of both crops will expand by about 15 percent. This results in sorghum and millet production increasing by more than their respective yields. Nonetheless net exports are projected to fall after 2025 in the optimistic scenario, reflecting increased domestic consumption of both sorghum and millet as a result of increased income to spend.

The IMPACT model was used to predict the number of malnourished children under five years of age, as well as the number of available kilocalories per capita. In the pessimistic and baseline scenarios, malnutrition rates for children under five years will rise to 600,000 by 2020, and then decrease to present levels by 2050. The optimistic scenario indicated a similar increase in the number of malnourished children until 2020, followed by a more significant decrease by 2050. Population growth should further shrink the proportion of malnourished children under five.

The trends in available kilocalories per capita across income and climate scenarios are consistent with those of the malnourishment rates above: In the pessimistic and baseline scenarios, kilocalories per capita decrease slightly until 2025–2030 (to about 1,400 kilocalories), and then return to present levels by 2050. The optimistic scenario shows a slight decrease, from about 1,800 in 2010 to 1,600 in 2025, followed by a 60 percent increase to 2,500 by 2050.

RECOMMENDATIONS

Among the recommendations advanced in the monograph from which this brief was drawn are the following.

- emphasize climate-change-adaptation strategies at the micro-level;
- engage in integrated planning that accounts for market responses, institutional changes, and technological developments;
- improve the nation’s capacity for seasonal climate forecasting ;
- facilitate courses on climate change and adaptation in agricultural colleges and universities;
- train extension staff;
- partner with nongovernmental organizations in long-term adaptation projects; and
- emphasize climate change and adaptation as an important focus for mainstream agricultural development initiatives.

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