The potential impacts of climate change on rice yields in Africa and options for adaptation

Rice and food security in Africa

- In Africa rice is the fastest growing staple crop in terms of consumption as well as production in Africa.
- Changing diets of urban population in combination with urbanization and fast population growth lead to strong increase in demand.
- The African countries together are the largest importer globally of Asian rice and depend heavily on international markets.
- Approximately 70% of the total rice production in Africa is under rainfed conditions in upland and lowland rice environments.
- Irrigated rice is cultivated under extreme temperature conditions, especially in the Sahel zone in West-Africa.
- Rice cultivation is vulnerable to the impacts of climate change due to reduced availability of surface and rain water and increases in minimum (night) temperature and maximum temperature.
- Rice is cultivated principally by smallholder farmers cultivating less than 1 hectare.

Methodology

- Changes in rice yields across Africa were simulated using a combination of spatial analysis and crop modelling.
- Climate change induced alteration in minimum and maximum temperature and atmospheric CO2 were considered.
- Spatial analysis was performed for 4 climate change scenarios (RCP 2.5, 4.0, 6.5 & 8.5) and 3 time slice (2030s, 50s & 70s).
- Downscaled monthly outputs of climate changes scenarios of all available GCMs were averaged.
- Monthly average Tmin and Tmax were crossed with location-specific rice calendars to obtain average changes during the rice cultivation seasons.
- Rice yields were simulated with the ORYZA2000 model for over 60 representative locations across Africa.
- Baseline conditions for the 2000s were simulated and seasonal average Tmin and Tmax for each location were used to develop the climate change scenarios.
- Projected changes in rice yields were then modelled for irrigated rice, rainfed lowland and rainfed uplands.
- Choice of improved rice varieties with longer duration was simulated as adaptation option to the projected changes.

Major findings

- Without adaptation, shortening of the growing period due to higher temperatures results in a yields decline of -24% in RCP 8.5 in 2070 compared to the baseline year 2000.
- With adaptation option rainfed rice yields would increase slightly (+4%) but they remain subject to water availability constraints.
- Irrigated rice yields in East Africa would increase (+25%) due to more favourable temperatures and due to CO2 fertilisation.
- Wet season irrigated rice yields in West Africa were projected to change by -21% with no adaptation or +7% with adaptation.
- Largest decreases of -45% were simulated for dry season rice cultivation in the Sahel zone.
- The main cause of this decline was reduced photosynthesis at extremely high temperatures and not due to heat sterility in rice grains.
- Climate change and adaptation options provide new opportunities in East Africa due to less cold stress.

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