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Irrigated rice yield response to projected climate change in northwest Bangladesh

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Abstract: Climate change poses a serious threat to rice production in Bangladesh, with rising temperatures and extreme weather events reducing yields, though elevated carbon-di-oxide (CO_2) may offer compensatory benefits. However, most existing studies in Bangladesh have primarily examined temperature impacts while neglecting the combined and interactive effects of temperature rise and CO_2 enrichment on rice growth and yield.

This study evaluated relative changes in the yield and phenology of irrigated rice across three key regions (Rangpur, Bogura, and Rajshahi) in northwest Bangladesh for the near future (NF: 2031–2065) and far future (FF: 2066–2100), relative to a historical baseline (1988–2022). The APSIM (Agricultural Production Systems Simulator) model was used, driven by climate data from 27 global climate models of CMIP6 (Coupled Model Intercomparison Project Phase-6) under two Shared Socioeconomic Pathways (SSP) scenarios: SSP245 and SSP585. Annual CO_2 concentrations were incorporated using scenario-specific regression equations.

Results indicate substantial warming, particularly in FF, with maximum temperature rising by up to 3.3°C (1.8°C) and minimum temperature up to 3.7°C (1.9°C) under SSP585 (SSP245). This increase is projected to shorten rice growth duration by up to 18 days under SSP585 and 10 days under SSP245. Rice yields were projected to increase in the NF by up to 14.7% and 8.6% under SSP245 and SSP585 scenarios, respectively. However, yields were expected to decline in the FF by 21% under the SSP585 scenario. These projected yield changes are primarily explained by variations in spikelet number (NSP) and spikelet fertility (SPFERT). While projected climate conditions enhance NSP by 16% in NF and 22% in FF, due to increased CO_2 concentration and solar radiation, SPFERT was projected to decline sharply, by up to 10% and 47% in NF and FF, respectively, under SSP585. The change in SPFERT was largely attributed to the change in elevated maximum temperatures during the anthesis period.

Although irrigated rice yield may initially benefit from future climate conditions, long-term projections highlight the need for adaptive measures such as improved agronomic practices and breeding heat-tolerant rice varieties to ensure sustainable production in Bangladesh.

Keywords: *Rice yield; Climate change; CO_2, APSIM model; Northwest Bangladesh*

