ABSTRACT

The study evaluated the impact of climate change on the irrigation water requirement (IWR) and crop water productivity (CWP) of rice in Pattambi, Kerala, using observed climate data from 1991-2022 and projected data for 2025-2095. Climate projections were based on four Global Climate Models (GCMs), MPI-ESM 1-2-HR, ACCESS-ESM 1-5, MPI-ESM 1-2-LR, and INM-CM-5-0 under SSP2 4.5 and SSP5 8.5 scenarios. GCM data was bias-corrected using linear scaling for temperature and power transformation for precipitation. The AquaCrop model, calibrated and validated with RMSE (0.3527-0.3728) and NSE (0.97-0.99), simulated rice yields and CWP, while CROPWAT 8.0 estimated ETo, ETc, and IWR for the baseline and future periods (2025-2049 (2035s), 2050- 2074 (2055s) and 2075- 2095 (2085s)).

The climate model INM-CM 5-0 exhibited strong agreement between observed and model-derived data with RMSE (1.5-4.80) and R^2 (0.5-0.85) in acceptable range. Future projections for the period 2025-2095 indicated that maximum temperatures could rise by +0.6, +0.84, and +0.89°C, minimum temperatures by +0.57, +0.85, and +1.2°C, and precipitation by +96.19, +122, and +214.23 cm during 2035s, 2055s and 2085s respectively under the SSP2 4.5. Under SSP5 8.5, the maximum temperature could rise by +0.66, +1.33, and +1.97°C, minimum temperatures by +0.67, +1.48, and +2.46°C, and precipitation by +159.3, +699.9, and +415.57 cm for the same time horizons. The AquaCrop model was calibrated and validated with RMSE (0.3527-0.3728) and NSE (0.99- 0.97) in the acceptable range for simulating rice yield.

Future projections of IWR indicated a remarkable rise in water demand both in Virippu (1st crop) and Mundakan (2nd crop) seasons. During Virippu, IWR is expected to increase by up to +42.63% and +37.97% under SSP2 4.5 and SSP5 8.5, respectively, while the same for Mundakan was found to be +4.20% and +11.65% respectively. This reflected higher water requirements for rice production under future climate change scenarios. Future yield projections showed a reduction in yield both in Mundakan (-51.72% and -42.12%) and Virippu season (-77.38% and -81.97%) under SSP2 4.5 and SSP5 8.5, respectively. However, the Virippu season

showed a more prominent reduction in yield than Mundakan. This significantly impacted CWP during Virippu, which showed a sharp reduction of -87.92% and -90.82%, and Mundakan showed a reduction of -66.36% and -46.36% under SSP2 4.5 and SSP5 8.5, respectively. Adopting early transplanting dates, particularly on April 21st, will help to increase yields (+26.2%) and reduce irrigation water requirements (-1.97%), while late transplanting should be avoided due to significant yield reduction in Virippu. But during the Mundakan season, transplanting dates on Oct 12th (in 2035s), Nov 11th (in 2055s), and Nov 21st (in 2085s) were found optimal due to increased yield (+2 - 9.8%). Adopting drip irrigation reduced water use by 20% and improved rice yields by +2.5%. Hence, it is concluded that, rising temperatures and rainfall under future climate scenarios are projected to increase IWR, reduce rice yields, and significantly lower CWP. Hence, adaptation measures are recommended to combat the effect of climate change and enhances CWP.