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Yield and Water Use of Alternative Production Systems in Tanzania: Field Experiments and Modeling

Abstract

Rice production is important for food security but given its large water footprint, alternative irrigation management strategies are needed. Three irrigation management alternatives were evaluated against the traditional continuously flooded rice (CF) system through field experiment and modeling approaches in Tanzania. The alternative irrigation strategies were implemented with the System of Rice intensification (SRI) practices. The three SRI treatments included applying full, 80% and 50% of the irrigation volume needed for traditional SRI. The experimental evaluation of treatments was conducted in the wet and dry seasons, using a complete randomized block design. Weather, crop, and soil measurements were made for both seasons. For the dry season, SRI and 80% SRI produced higher yields of 9.68 tons/ha and 11.45 tons/ha and saved 26% and 35% of water, respectively compared to CF (8.69 tons/ha). The yield advantage of 80% SRI and SRI over CF, for the wet season was less than the dry seasons; 80% SRI and SRI produced 6.01 tons/ha and 5.99 tons/ha and saved 33% and 18% of water, respectively compared to CF (5.64 tons/ha). The 50% SRI had lowest yield of all, 7.48 tons/ha and 4.99 tons/ha with 54% (693 mm) and 57% (425 mm) water saving compared to CF for the dry and wet seasons, respectively. On average, 80% SRI treatment outperformed all other treatments with an additional yield of 1.57 tons/ha and 33.9% water savings (344 mm) compared to the CF. Field-verified rice model (ORYZA2000) was used to evaluate different levels of irrigation input with SRI practices. Simulation results for the calibration (dry season) and the validation (wet season) indicated that model performance was satisfactory. The Nash-Sutcliffe efficiency (E) for yield predictions ranged from 0.69 to 0.89 for the dry season, and 0.60 to 0.83 for the wet season. The E values for simulated soil moisture ranged from 0.68 to 0.89 for the dry season and 0.62 to 0.73 for the wet season. Simulation of irrigation scenarios indicated that irrigating at 75% SRI and 70% SRI produced highest yield for the dry and wet seasons, respectively. Extrapolation of results from this study to Tanzania showed water savings of 422,223 ha-cm with additional 4.9 million tons of yield.