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Understanding the potential of adjusted water management to lower the global warming potential of rice in India

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Abstract

Agricultural production and food security are facing challenges due to weather extremes and climate change. While rice is commonly grown in Asia's most productive cropping systems, its irrigation water demand is high, and the water use efficiency is relatively low when continuously flooded (CF). Climate change will likely make it more difficult to sustain yields with the currently available management practices. Implementing alternate wetting and drying (AWD) irrigation rather than CF reduces rice production's water footprint and creates aerobic soil conditions that limit methanogenesis. However, the potential rise in nitrous oxide (N_2O) emissions during the aerobic phase should be considered when assessing greenhouse gas (GHG) emissions and the overall global warming potential (GWP) of this method. Working with smallholders (< 0.5 ha) on a pilot study in Haryana, India, we compared the GHG emissions between AWD and CF irrigation of puddled transplanted rice (TPR) in kharif season (July–October) of 2023. Results revealed a very distinct and lower seasonal range of CH_4 flux for AWD (12–17 kg ha^{-1}) compared to CF (33–57 kg ha^{-1}). However, the seasonal range of N_2O emissions for AWD (0.74–0.99 kg ha^{-1}) exceeded that of CF (0.50–0.88 kg ha^{-1}). Despite a greater seasonal N_2O flux, rice grown under AWD exhibited a lower average seasonal GWP of 582 kg CO_2-eq ha^{-1} compared to CF of 1177 kg CO_2-eq ha^{-1}, representing an approximately 51 % reduction in the GWP of TPR by shifting to AWD as an irrigation management strategy. Building on these promising results, we have expanded our evaluation of AWD in the kharif season of 2024 to include smallholders in Madhya Pradesh and Andhra Pradesh, states with different irrigation water management options. We aim to enhance remote sensing methodologies to optimise Monitoring, Reporting, and Verification (MRV) of low-emission practices, including standard operating procedures and model scaling. Additionally, we plan to complement on-field measurements with biogeochemical modelling (e.g., DNDC) to understand AWD's potential across different states of India.

Keywords: Alternate wetting and drying, DNDC, methane, MRV, remote sensing

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