Understanding the Potential of Adjusted Water Management to Lower the Global Warming Potential of Rice in India

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Background

- **Challenges in Agriculture:** Agricultural production and food security are threatened by weather extremes and climate change
- **Rice Cultivation Issues:** Rice, predominantly grown in Asia, requires high irrigation water and has low water use efficiency under continuous flooding (CF)
- **Impact of Climate Change:** Sustaining rice yields with current practices may become more difficult due to climate change
- **Low Emission Water Management Practices:** Mid-season drainage, controlled irrigation, and intermittent flooding optimize soil conditions to reduce GHG emissions
- **Alternate Wetting and Drying (AWD):** AWD irrigation can reduce water use and create aerobic soil conditions that limit methane emissions. However it may increase nitrous oxide (N_2O) emissions
- **Remote Sensing Technology:** Remote sensing methods can accurately map the rice crop phenology at different stages, and provide precise information on water management practices, enabling the development of targeted interventions for reducing GHG emissions in rice cultivation

Methodology

AWD pipe

GHG sampling in rice field by static chamber method

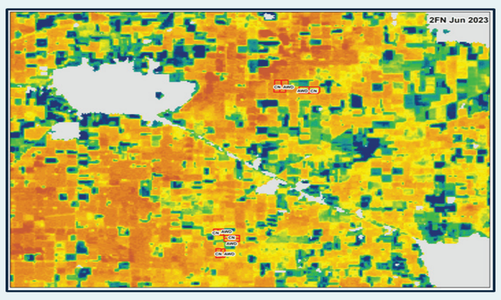

Fig 1. Time-series satellite images to monitor and report the rice area phenology with hydro period

- **Study Location:** Pilot study in Haryana, India, with small land holding farmers (< 0.5 ha)
- **Comparison of Irrigation Methods:** Evaluated GHG emissions between AWD using AWD pipe and CF irrigation in puddled transplanted rice (TPR) during the kharif season (June–November) of 2023 by static chamber method
- **Geospatial Analytics:** Sentinel-2 (10m) time series remote sensing images were analysed for developing the rice phenology stages using the Normalized Difference Vegetation Index (NDVI)
- The hydro period dynamics from the Normalized Difference Water Index (NDWI) were evaluated for the experimental trials and surrounding rice fields

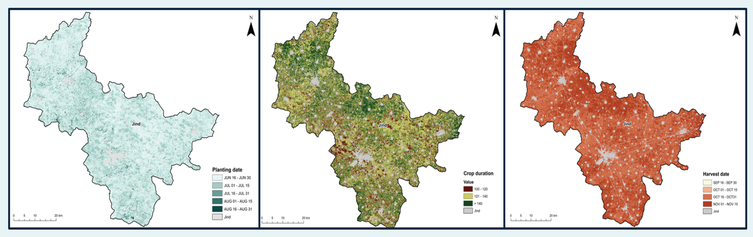

Fig 2. Rice phenology maps developed for Jind district, Haryana during the Kharif season (June to November) of 2023

Results

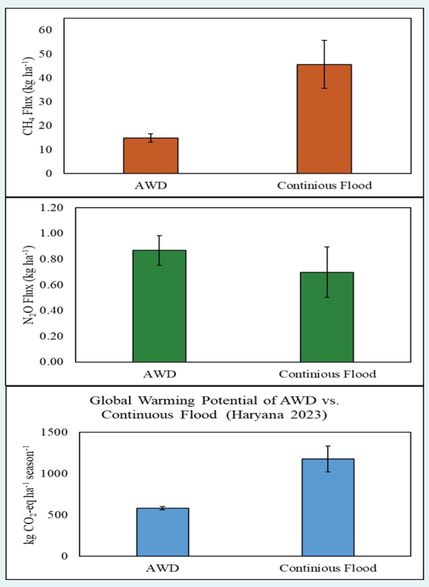

Fig 3. Cumulative N_2O and CH_4 emissions and global warming potential under AWD and continuous flooding as observed in Jind district, Haryana in Kharif 2023

- A ~51% reduction in CO_2-eq was observed with AWD as compared to continuous flood

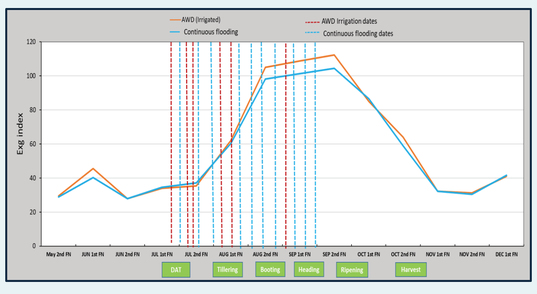

Fig 4. Excess Green Vegetation Index (EXGI) spectral profile in rice crop stages for AWD and continuous flooding method

- EXGI spectral profile of AWD irrigation method has better performance when compared to continuous flooding method

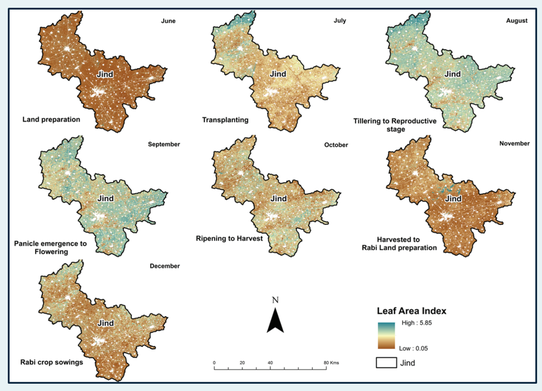

Fig 5. Leaf Area Index (LAI) maps developed for Jind district of Haryana during Kharif season (June to November) 2023

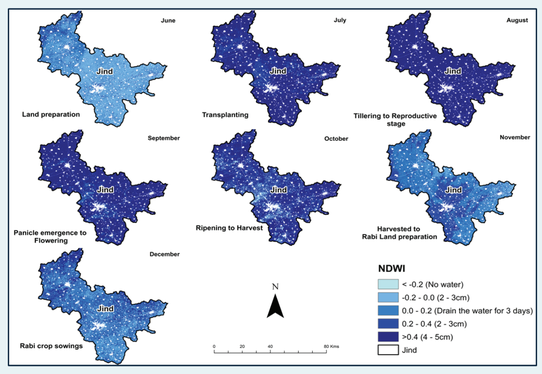

Fig 6. Normalized Difference Water Index (NDWI) maps developed for Jind district, Haryana during the Kharif season (June to November) of 2023

- The Leaf Area Index (LAI) is a dimensionless quantity that characterizes plant canopies analysed using the Sentinel-2 time series imageries
- The Normalized Difference Water Index (NDWI) is a satellite-based index that measures water content in vegetation and water bodies in the rice field at different stages

Way Forward

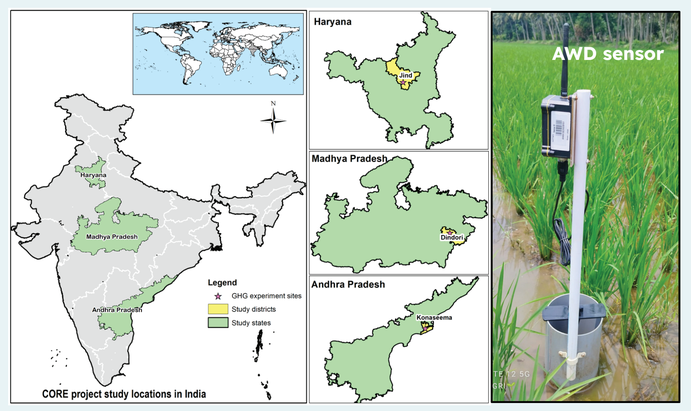

Fig 7. CORE project study locationsin India

- **Expansion to Different Agro-Climatic Zones:** GHG experiments are being conducted in the rice fields of Andhra Pradesh, Haryana, and Madhya Pradesh in 2024
- **Natural Farming Impact:** Pioneering GHG emission assessments of natural farming in Andhra Pradesh
- **Water Monitoring:** In-field AWD sensors for precise and continuous field water monitoring
- **AWD Potential:** Integrate the DNDC biogeochemical model with field data to predict GHG emissions and soil health across diverse agro-climatic zones
- **Digital MRV:** Remotely-sensed information will be integrated with precision technologies and machine learning to develop a cost-effective and efficient monitoring, reporting and verification (MRV) option
- **ALOS PALSAR L-band:** Images acquired from Japan Aerospace Exploration Agency will be used to map the hydroperiod dynamics in the experimental trials of Andhra Pradesh

Key Takeaway

Implementing AWD practices enables smallholder farmers to earn carbon credits by quantifying and monetizing GHG reductions, thereby promoting sustainable agriculture through economic incentives.

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