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Carbon and water cycling in flooded and rainfed rice (Oryza Sativa) ecosystem: Disentangling agronomical and ecological aspects of water use efficiency

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Agricultural crops play an important role in the global carbon and water cycling process and there is intense research to understand and predict carbon and water fluxes, productivity and water use of cultivated crops under climate change. Mechanistic understanding of the trade of between ecosystem water use efficiency and agronomic water use efficiency to maintain higher crop yield and productive water loss is necessary for the ecosystem sustainability. . We compared water and carbon fluxes of paddy and rainfed rice by canopy scale gas exchange measurements, crop growth, and daily evapotranspiration, transpiration and carbon flux modeling.

According to our findings, evaporation contributed strongly (maximum 100% to minimum 45%) to paddy rice evapotranspiration while transpiration of rainfed is almost 50 % of daily evapotranspiration. Water use efficiency (WUE) was higher in rainfed rice both from an agronomic (WUEagro, i.e. grain yield per evapotranspiration) and ecosystem (WUEeco, i.e. gross primary production per evapotranspiration) perspective. However, rainfed rice showed also high ecosystem respiration losses and a slightly lower crop yield, demonstrating that higher WUE in rainfed rice comes at the expense of higher respiration losses of assimilated carbon and lower plant production, compared to paddy rice. Our results highlighted the need to partition water and carbon fluxes to improve our mechanistic understanding of water use efficiency and environmental impact of different agricultural practices.

Keywords: Rainfed rice, Paddy rice, water use efficiency, Transpiration/Evapotranspiration, ecosystem WUE, agronomic WUE, Evapotranspiration