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Water flow mechanisms and unproductive water losses in rice-based cropping systems in the humid tropics

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In rice production areas in the world, increasing water scarcity is a major problem. Among the water saving techniques, integrating water saving non-flooded crops into the flooded rice system during the dry season is one of the promising water-saving approaches. Therefore, there is a necessity to improve the understanding of the water flow dynamics and losses in crop rotational systems under different climatic conditions in irrigated agricultural fields. That understanding can be used to lower the water requirements to build more efficient water management systems. We experimentally investigated the water flow processes and water losses by introducing non-flooded crops during the dry season (dry rice and maize) followed by flooded rice in the wet season and compared this to flooded rice in both seasons. We measured stable isotopes of water (δ^2H and $\delta^{18}O$) in extracted soil water and liquid samples (Groundwater, ponded surface water, rainwater, and irrigation water). The Craig–Gordon equation was applied to estimate the fraction of evaporation losses. Results reveal that the soil isotopic profile patterns reflect the soil water transport processes and differ depending on the irrigation frequencies and crop diversification. Matrix flow and slow soil water infiltration, soil evaporation, and preferential flow via desiccation cracks were identified as the main water flow mechanisms in the irrigated fields. During the dry season, the evaporation effect on soil water is higher and water losses decreased from the beginning towards the end of the seasons. However, greater unproductive water losses were estimated during the wet season compared to the dry season. Finally, the results suggested that introducing dry seasonal crops to the crop rotation system for reducing the unproductive water losses is a good alternative method.