



Adaptation and sustainability of rice cultivation in warming and drying temperate regions

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The largest European rice production is located in northern Italy, where paddy field flooding management evolved from the traditional continuous flooding to a less greenhouse-gases-emitting practice i.e. dry seeding with postponed flooding. This agro-management and land-use change resulted in the largest anthropogenic reduction of seasonal surface water extent detected in Europe around year 2000. At the same time, regional climate rapidly changed towards sunnier weather conditions that contributed to higher rice yields and stability, but also reduced water availability. Before 2000, yields were strongly anti-correlated to the downstream river discharge, which acted as a proxy for unfavorable weather conditions. Analogue conditions currently characterise other important rice producing countries such as Uruguay, Argentina, North Korea and USA. In the context of near-term climate changes, sustainable rice cultivation in the middle latitudes seems achievable without limiting production and/or increasing volatility. However, albeit saving water, the shift to rice dry seeding is inconsistent with the seasonality of water availability in northern Italy. This analysis also identifies environmental disadvantages of dry seeding compared to the traditional wet seeding.