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Water efficient rice production - Short-term benefits at the expense of long-term fertility?

John Livsey (1,2), Thomas Kätterer (3), Giulia Vico (4), Steve Lyon (1,2,5), Regina Lindborg (1,2), Anna Scaini (1,2), Stefano Manzoni (1,2)

(1) Stockholm University, Department of Physical Geography, Stockholm, Sweden, (2) Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden, (3) Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden, (4) Department of Crop Production Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden, (5) The Nature Conservancy, Delmont, USA

While many agricultural practices have resulted in loss of soil organic carbon (SOC), paddy rice production often presents favourable conditions for carbon sequestration. At the same time, it is a major source of methane emissions and a large water user. The introduction of water saving irrigation (WSI) practices, such as alternate wetting and drying (AWD) and mid-season drainage (MSD), have been suggested as strategies for decreasing the large water demands of paddy rice production. With the removal of anaerobic conditions during the growing season, they may also lower CH_4 production and reduce the global warming potential of rice production. However, the long-term impact of WSI on SOC - an indicator of soil health and fertility - has been little explored. Through a meta-analysis we assessed the effects of WSI on SOC storage and GHG emissions. AWD and MSD reduced emissions of CH_4 by 52.3%, and increased those of CO_2 and N_2O by 44.8 and 30% respectively. WSI reduced CO_2-equivalent emissions by 52% but increased the soil-to-atmosphere flux of carbon by 24% when compared to flood irrigation. Moreover, WSI decreased SOC concentrations by 8.2% when compared to flood irrigation. While WSI affects SOC and greenhouse gas emissions, it has been shown to potentially have little effect on rice yield. However, evidence of yield stability is limited to short-term (1-2 years) experiments, whereas soil properties change over decades. Therefore, care should be taken when assessing the long-term sustainability of these irrigation practices because WSI can decrease soil fertility. The development of future irrigation strategies should consider long-term effects and trade-offs between water savings, fertility, other ecosystem services and climate change mitigation.