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Co-development of climate smart flooded rice farming systems

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Mid-season drainage in flooded rice is known to reduce CH_4 emission, while effects on N_2O emission are more variable. Banning of crop-residue burning, and growing markets for organically fertilized rice, are resulting in systems with larger reactive C input, and potentially larger methane emissions. Tight farming systems with 2 or 3 annual crops are effective in mitigating emissions, in that the land sparing value is high, but put serious constraints on mitigation options under increased C input scenarios. In a series of field (Cambodia, Philippines and Vietnam) and greenhouse experiments, we investigated the effect of a variety of organic amendments and wetting and drying cycles on yield and GHG emissions. Specifically we have tested the effect of inserting very early, or even-pre-planting drainage, as a means to accelerate turnover of straw or other C sources, and reduce methane emission later in the season. Overall, our results showed that drying periods had minimal impact on yields, while reducing overall GHG emission. Methane emission was strongly controlled by C availability in the substrate (on equal total C-input basis), increasing in the order: biochar-composts-animal manure-fresh material. Nitrous oxide emissions generally increased with draining cycles, but did not lead to overall increase in GHG emissions as its contribution was balanced by lowered CH_4 emissions. Growth chamber experiments showed that methane emission was significantly reduced for extended periods after re-flooding, hence the idea of early drainage was developed. Meanwhile, Cambodian farmers expressed concerns over re-supply of water after drainage. In response to that, we tested if early-season drainage could replace mid-season drainage. With addition of labile carbon substrates (straw) duration of early season drainage was more important for reducing GHG emissions, than duration of mid-season drainage, and had the highest potential for total emission reduction. In a farmers-field trial in Vietnam, pre-planting and early season drainage was tested in spring and summer rice, under individual and community water management regimes, and at 2 straw application levels. Pre-season drainage was difficult for farmers to implement, due to the short duration of fallow between cropping seasons. Early season drainage was most effective in lowering methane emissions at both straw application levels. Unsurprisingly, the well-managed drainage control (community system) was significantly more effective in mitigating emissions, than the individually water management. Surveys among farming communities in Philippines, subject to agricultural campaigns on alternate-wetting-and-drying showed higher adoption among farmers who actively pumped water to their fields, compared to gravity-fed water supply, due to the direct savings experienced by farmers pumping water. Several other factors positively influenced adoption of mitigation techniques, including education level, access to extension services, wealth and farm size, and age of farmer (negatively correlated to adoption rate). In conclusion, drainage periods are even more important to mitigate emissions when including organic manures or residues in flooded rice, and early-season drainage should be further explored as a more safe and convenient option for smallholders. Participatory development of climate smart prototypes will be essential, and a model for such is presented.