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Introducing non-flooded crops in rice-dominated landscapes: Impact on carbon, nitrogen and water cycles

IRRI International Rice Research Institute

DFG


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# Global Warming Potential of Diversified Tropical Rice Rotations after Straw Return and Legume Intercropping

## Introduction

Water regime and agricultural management controls soil $CH_4$ and $N_2O$ emission, but also $CO_2$ emission and soil C sequestration

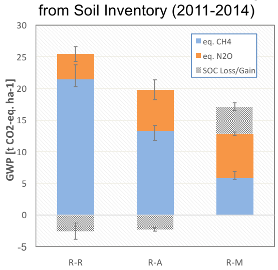
$CH_4$ — $N_2O$ / $CO_2$




➢ Conversion of traditional rice-rice (**R-R**) crop rotation to diversified rotations with aerobic rice (**R-A**) or maize (**R-M**) during dry season will lead to **pollution swapping**, but overall to a decrease of the total GWP

- Pollution swapping from $CH_4$ to $N_2O$ occurs under dryer conditions in the non-flooded crops, most distinctly for maize
- Due to high rates of $CH_4$ emissions at paddy rice cultivation total GWP from non-flooded crop cultivation (maize, aerobic rice) is lower than from paddy rice

GWP and estimated SOC change from Soil Inventory (2011-2014)




**Constraint:** Losses of soil organic carbon (SOC) in maize and aerobic rice rotations may lead to overall higher GWP compared to flooded rice

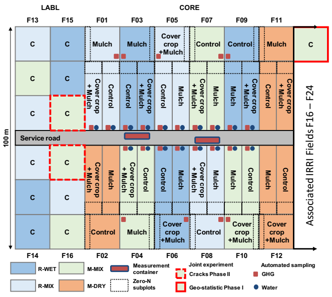
➢ SOC loss of 0.5 t C $ha^{-1}$ $yr^{-1}$ in upland systems would reverse the beneficial effect on GWP

**New management practice:** Incorporation of organic amendments to diversified rice rotation will reduce overall yearly GWP due to potential SOC sequestration

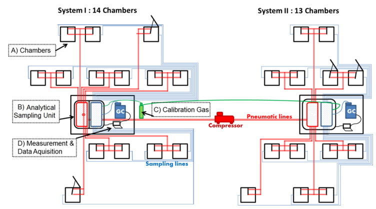
**Objective:** to quantify and provide a comparative assessment of GWP of diversifying rice cropping systems and evaluate mitigation potentials or risks of new management practices i.e. straw mulching and legume inter-crop cultivation

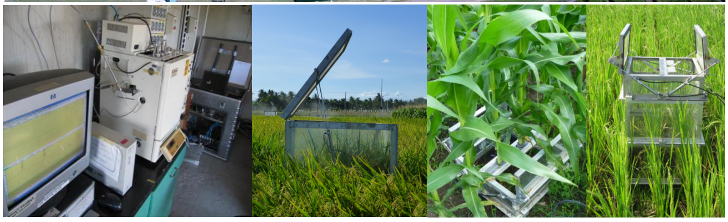
## Field Experiment

**Experimental layout**




**Automated chamber measurements** at IRRI field site, Philippines (2011 – 2017)



**Rice Straw Mulching**

| Treatment | Dry Season | Wet Season |
|---|---|---|
| Control | - | - |
| Straw | Rice straw[1)] | - |
| Mungbean + Straw | Rice straw[1)] | Mungbean[2)] |

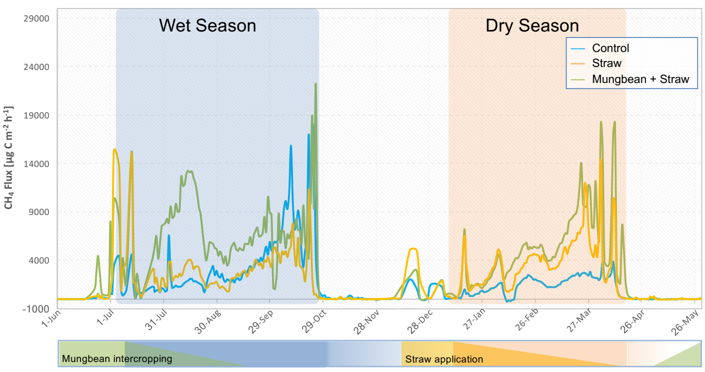
1) 3 t $ha^{-1}$ applied as mulch, 3 t $ha^{-1}$ incorporated into soil with land preparation for dry season

2) seeded as cover/catch crop after dry season, incorporated before wet season (ca. 6.5 t $ha^{-1}$)

**Legume intercropping**

## Results

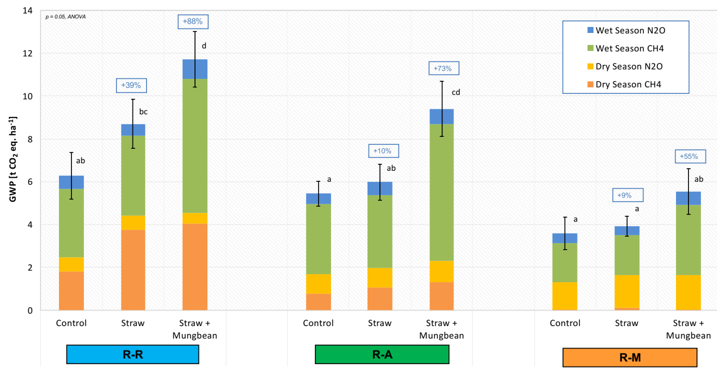
Annual $CH_4$ flux from traditional rice rotation (R-R) affected by organic amendments (mid 2015 - mid 2016)




➢ org. C input by straw mulching and legume intercropping to flooded fields is promoting $CH_4$ emissions, due to higher substrate availability for methanogens

➢ even though organic amendments had a significant effect on $N_2O$ fluxes, differences in water management across crop rotations was the overall controlling factor for magnitude of $N_2O$ emissions (R-M > R-A > R-R)

Annual global warming potentials (GWP) of three rice crop rotations affected by organic amendments (2015 & 2016)




➢ GWP of crop rotations generally increased for the treatments with org. C incorporation

➢ effect was much less pronounced on upland crop rotations (R-M, R-A)

➢ overall, impacts of organic matter incorporation on GWPs were beneficial in diversified rice crop rotations when considering a potential SOC sequestration

## Conclusion

➢ incorporation of crop residues (rice straw or mungbean) during/before flooded periods is not advisable as it will increase GWP, mainly driven by enhanced $CH_4$ emissions

➢ regarding a future expansion of lowland-upland rotations due to water scarcity in SE-Asia it can be expected that input of crop residues can counteract the SOC loss that is likely associated with the shift to more aerated soil conditions under upland crops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