GOBESHONA 5

8 - 11 January 2019

International Conference on Climate Knowledge

Impacts of fertilizer and water management on greenhouse gas emissions and nitrogen use efficiency from lowland rice cultivation

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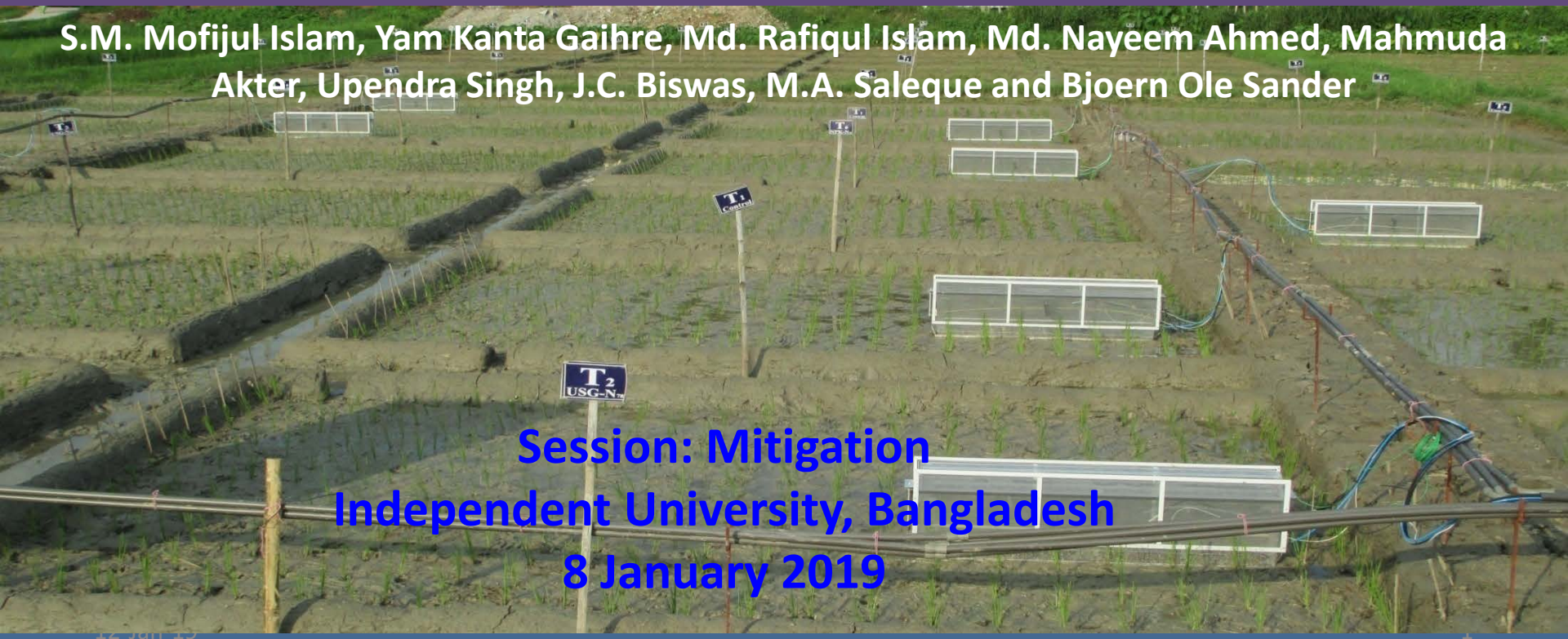

Session: Mitigation

Independent University, Bangladesh

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Introduction

- Staple food
- Rice and greenhouse gases (GHG)
- Global warming

Likely impact in agriculture

Objectives

- To determine the effects of PU vs UDP on floodwater NH_4^+-N, NH_3 volatilization, greenhouse gasemission, grain yield and NUE
- To compare the effects of water management on GWP in dry season.
- To find out an efficient N and water management option for increased crop productivity with reduced negative environmental impacts.

Materials and Methods

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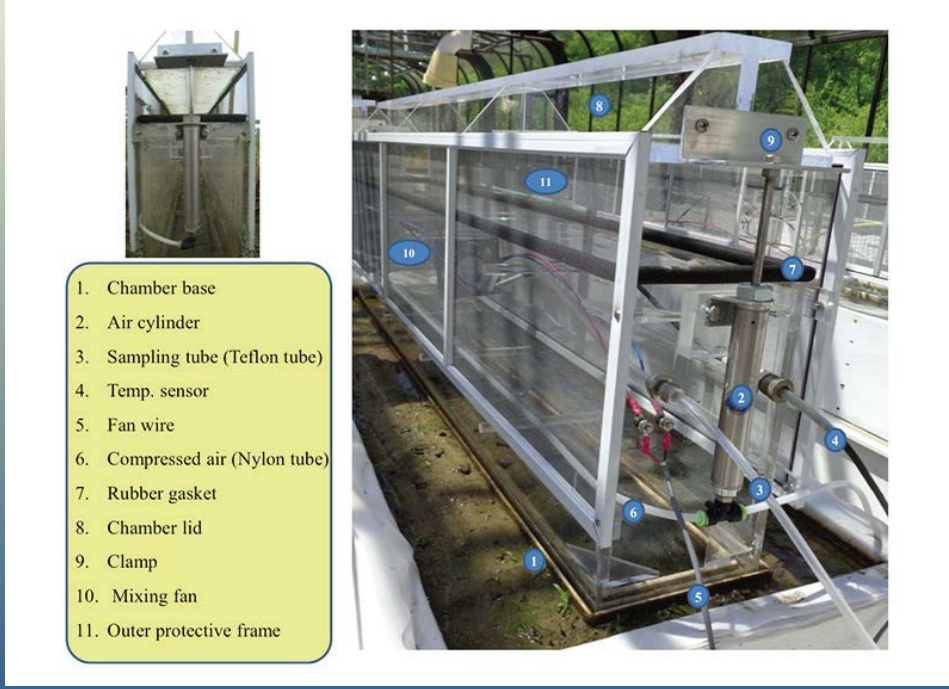
- Seasons
- Treatments: 3 → **Control**, **UDP**, **PU**
- Design: RCB
- Replication: 3

N_2O and NO gas measurement

- Gas chambers were installed in respective plots over aluminum base. N_2O and NO gas were measured with an automated closed chamber technique.



CH_4 gas measurement

- Closed gas chamber (manual sampling)
- Gas sampling was done once a week at 15 min interval (0,15 and 30 min).
- Gas conc. was measured using GC Analyzer.

Results and Discussion

Table. The interaction effects of water regime × N application methods on grain yield (GY) and recovery efficiency of N at BRRI farm, Gazipur.

Treatment	GY (t ha^{-1})		RE_N (kg N uptake N kg^{-1})	
	AWD	CSW	AWD	CSW
Control	1.91c	1.79c	–	
Urea briquette	4.95a	4.99a	56.4a	58.4a
Prilled urea	3.85b	4.20b	21.2b	30.3b
Mean	3.57A	3.66A	38.8B	44.3A
ANOVA (p Values)				
Treat (T)	0.000		0.000	
Water (W)	0.328		0.049	
T × W	0.127		0.188	

Floodwater NH_4^+-N and NH_3 volaltilization

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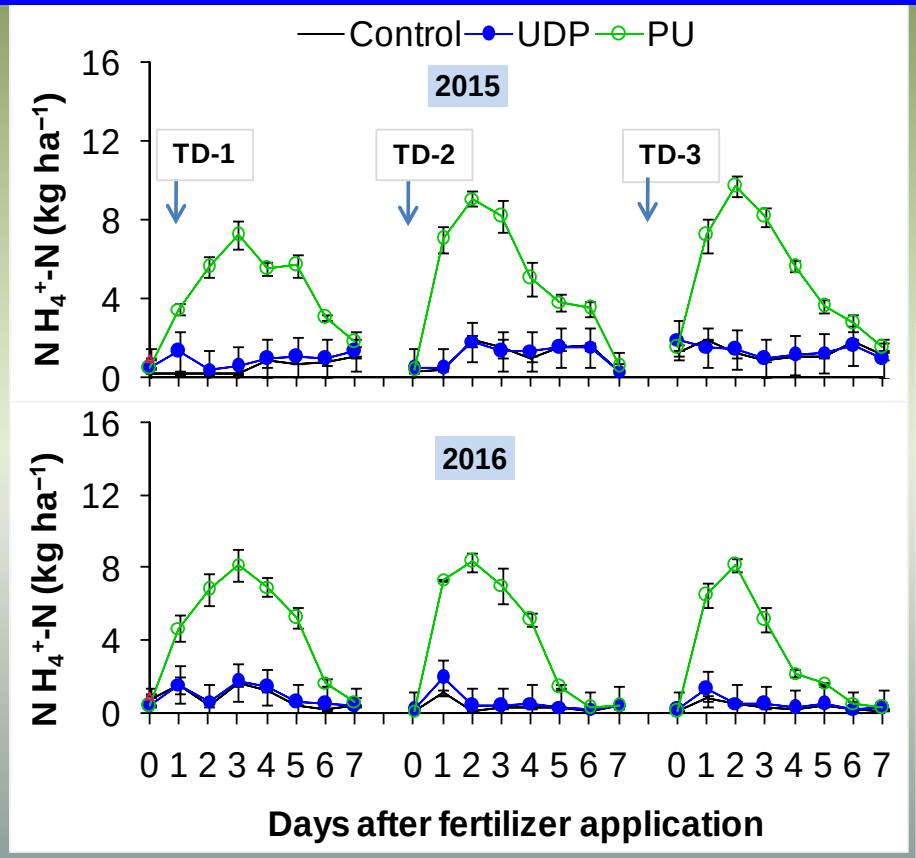

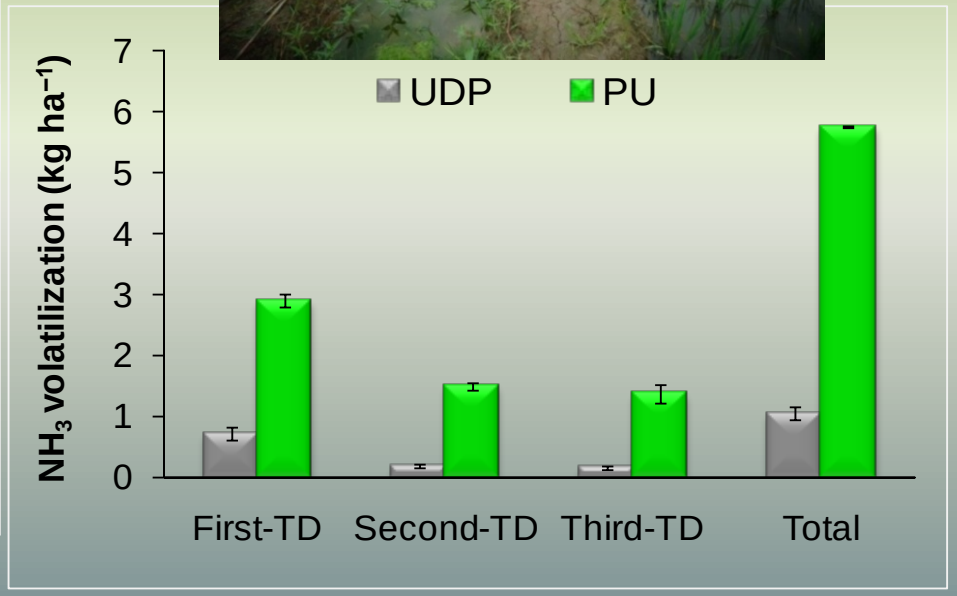

Fig. Changes in floodwater NH_4^+-N and NH_3 volatilization in control, UDP and PU treat under AWD in dry season. Vertical bars indicate standard error of mean (n=3).

Cumulative nitrous oxide (N_2O) emission

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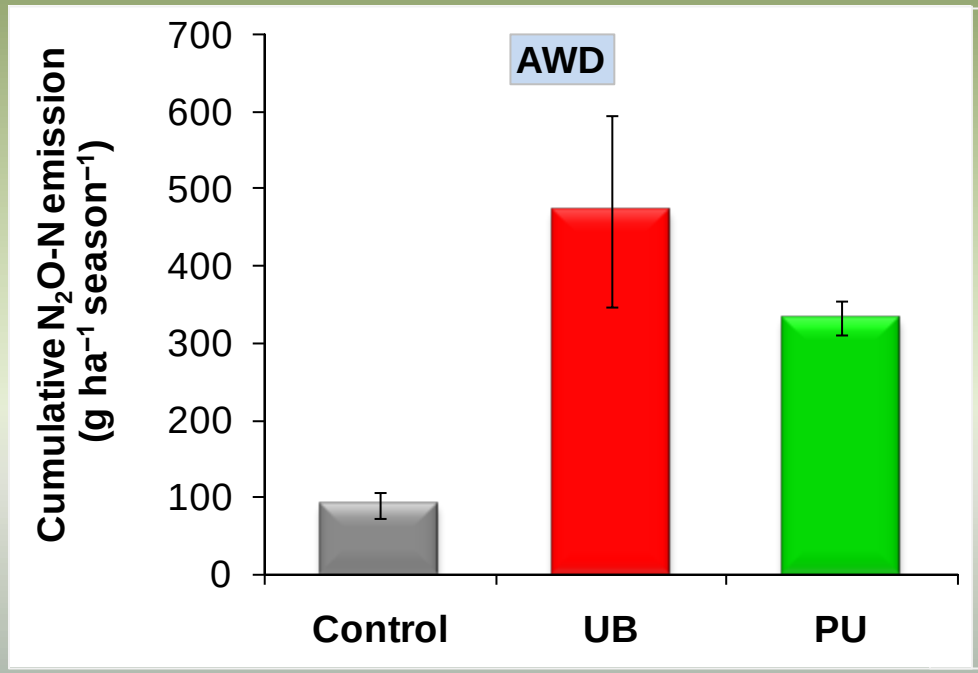

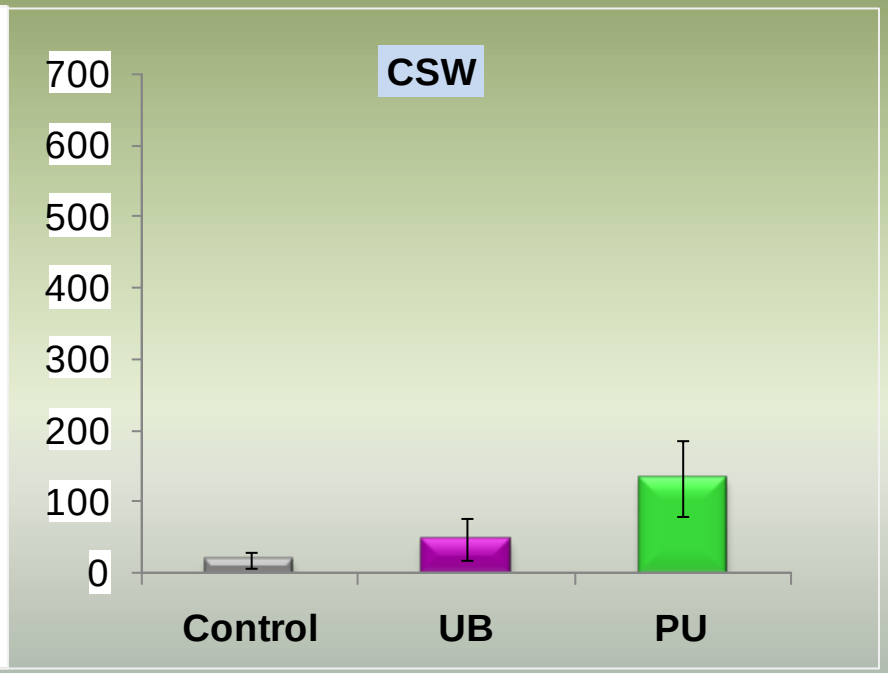

Fig. Impacts of N fert. and water management on cumulative N_2O-N emission during dry season at BRRI farm, Gazipur. CSW indicate continuous standing water.

Yield-scaled N_2O emission

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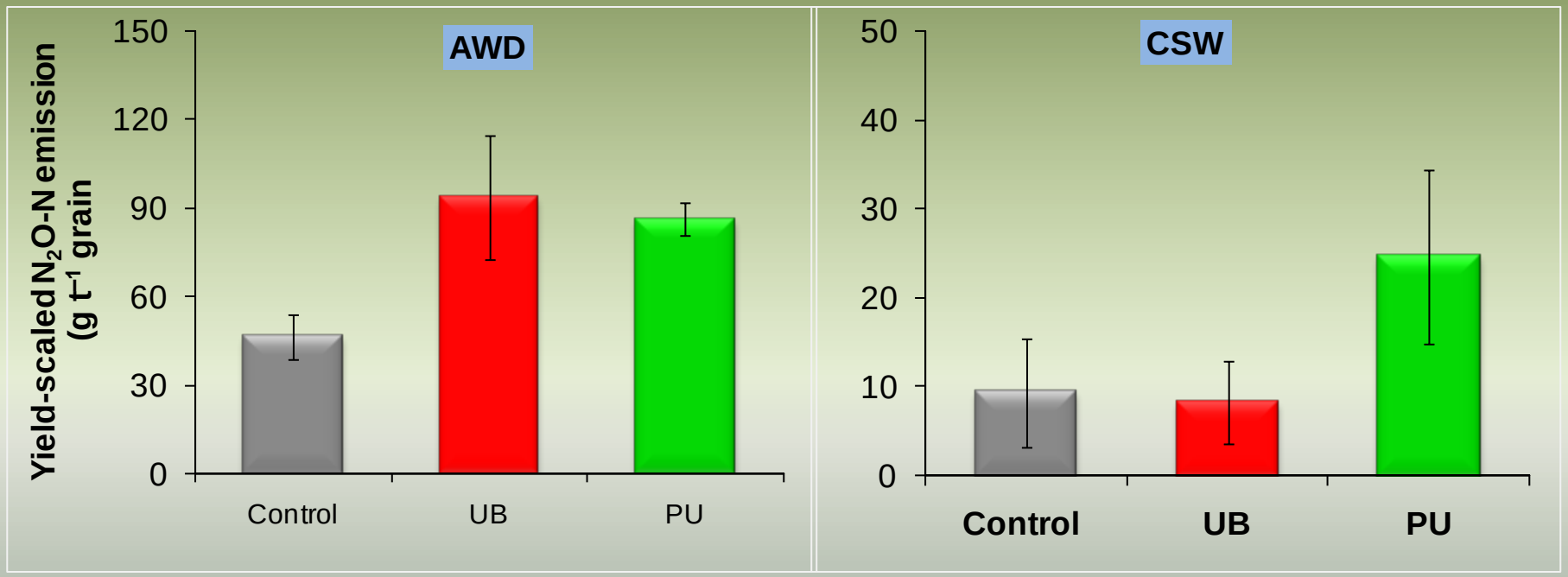

Fig. Impacts of N fert. and water management on yield-scaled N_2O-N emission during dry season at BRRI farm, Gazipur. CSW indicate continuous standing water.

Cumulative nitric oxide (NO) emission

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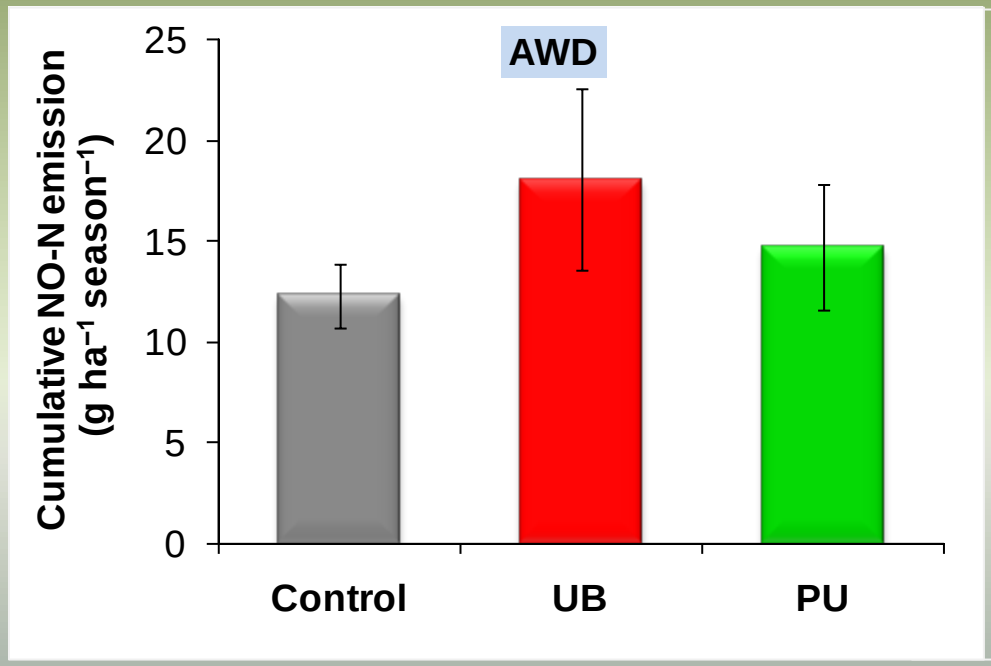

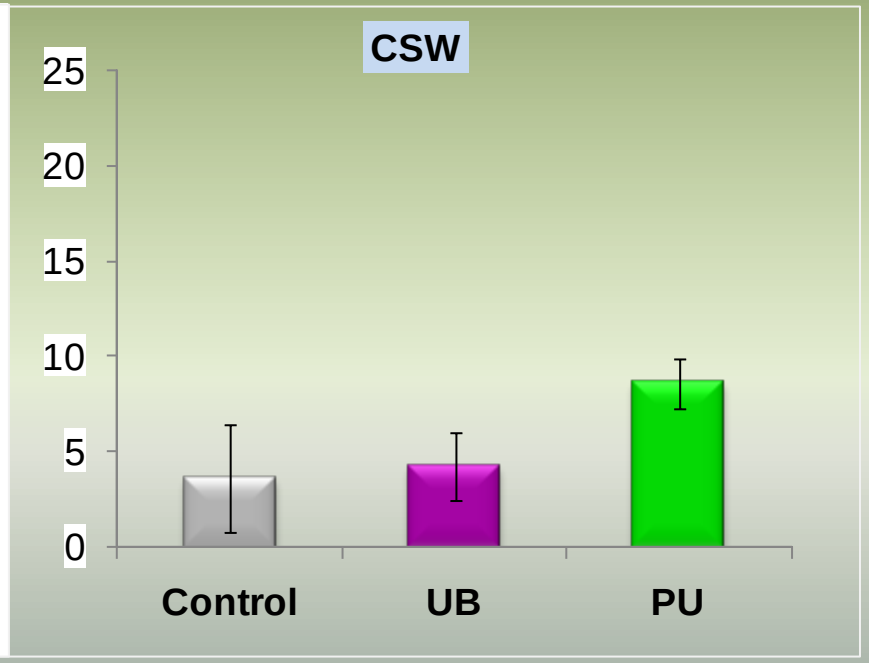

Fig. Effects of N fert. and water management on cumulative NO-N emission during dry season at BRRI farm, Gazipur. CSW indicate continuous standing water.

Seasonal cumulative CH_4 emission

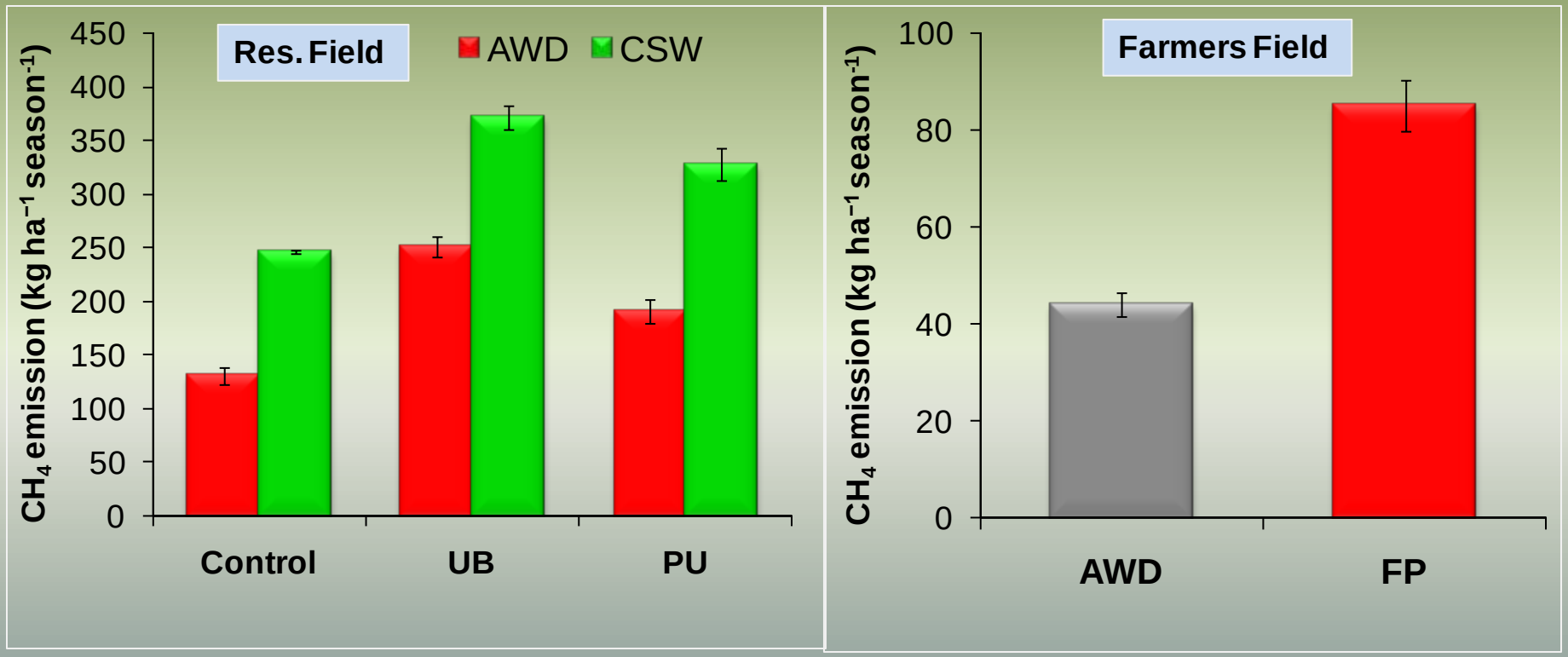

Fig. Effects of water management on cumulative CH_4 emission during dry season.

Global Warming Potential (GWP)

Table. Impacts of fertilizer and water management on CH_4 and N_2O emission and GWP in dry seasons

Treat.	Total CH_4 flux (kg ha^{-1} sea^{-1})		Total N_2O flux (g ha^{-1} $seas^{-1}$)		GWP (kg CO_2 eq. ha^{-1} $season^{-1}$)[a]		% GWP reduction
	AWD	CSW	AWD	CSW	AWD	CSW	-
Control	131	246	90	19	3698	6891	46
UDP	251	372	470	48	7327	10425	30
PU	191	328	332	133	5556	9237	40
Average	191	315	297	67	**5874**	**8868**	**39**

[a]GWP (global warming potential) of CH_4 and N_2O were calculated by multiplying 28 and 265 on seasonal CH_4 and N_2O fluxes, respectively.

Conclusion

- Deep placement of urea briquette significantly increased rice yield compared to PU, additionally it could save N by 20-30% without any yield penalty (**Islam et al., 2018**).
- UDP significantly reduced floodwater NH_4^+-N, and NH_3 volatilization compared to PU (**Islam et al., 2016, 2018**).
- UDP and PU showed similar N_2O fluxes in AWD condition, while UDP significantly reduced N_2O fluxes over PU in CSW practice (**Gaihre et al., 2015, 2018, Islam et al., 2018**).

- **Across the water regimes, UDP reduced GWP by 10% compared to broadcast PU**
- **Across the N management, AWD irrigation reduced GWP by 39% compared to CSW condition in dry season.**

Publications

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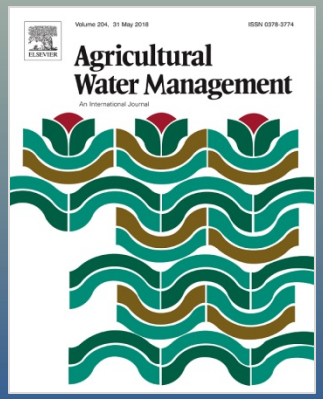
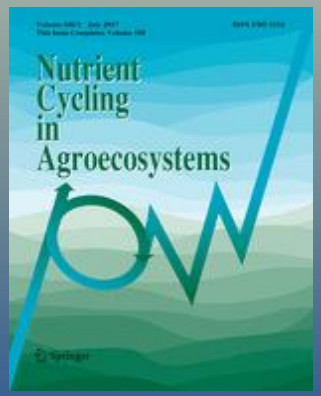
Islam, S.M.M., Gaihre, Y.K., Biswas, J.C., Singh, U., Ahmed, M.N., Sanabria, J., Saleque, M.A., 2018. Nitrous oxide and nitric oxide emissions from lowland rice cultivation with urea deep placement and alternate wetting and drying irrigation. Scientific Reports, 8, DOI:10.1038/s41598-35939-7

Islam, S.M.M., Gaihre, Y.K., Biswas, J.C., Jahan, M.S., Singh, U., Adhikary, S.K., Satter, M.A., Saleque, M.A., 2018. Different nitrogen rates and methods of application for dry season rice cultivation with alternate wetting and drying irrigation: Fate of nitrogen and grain yield. Agricultural Water Management, 196, 144-153.

Gaihre, Y.K., Singh, U., **Islam, S.M.M.,** Huda, A., Islam, M.R., Sanabria, J., Satter,M.A., Islam, Md.R., Biswas, J.C., Jahiruddin, M., Jahan, M.S., 2018. Nitrous oxide and nitric oxide emissions and nitrogen use efficiency as affected by nitrogen placement in lowland rice fields. Nutrient Cycling in Agroecosystems, 110, 277-291.





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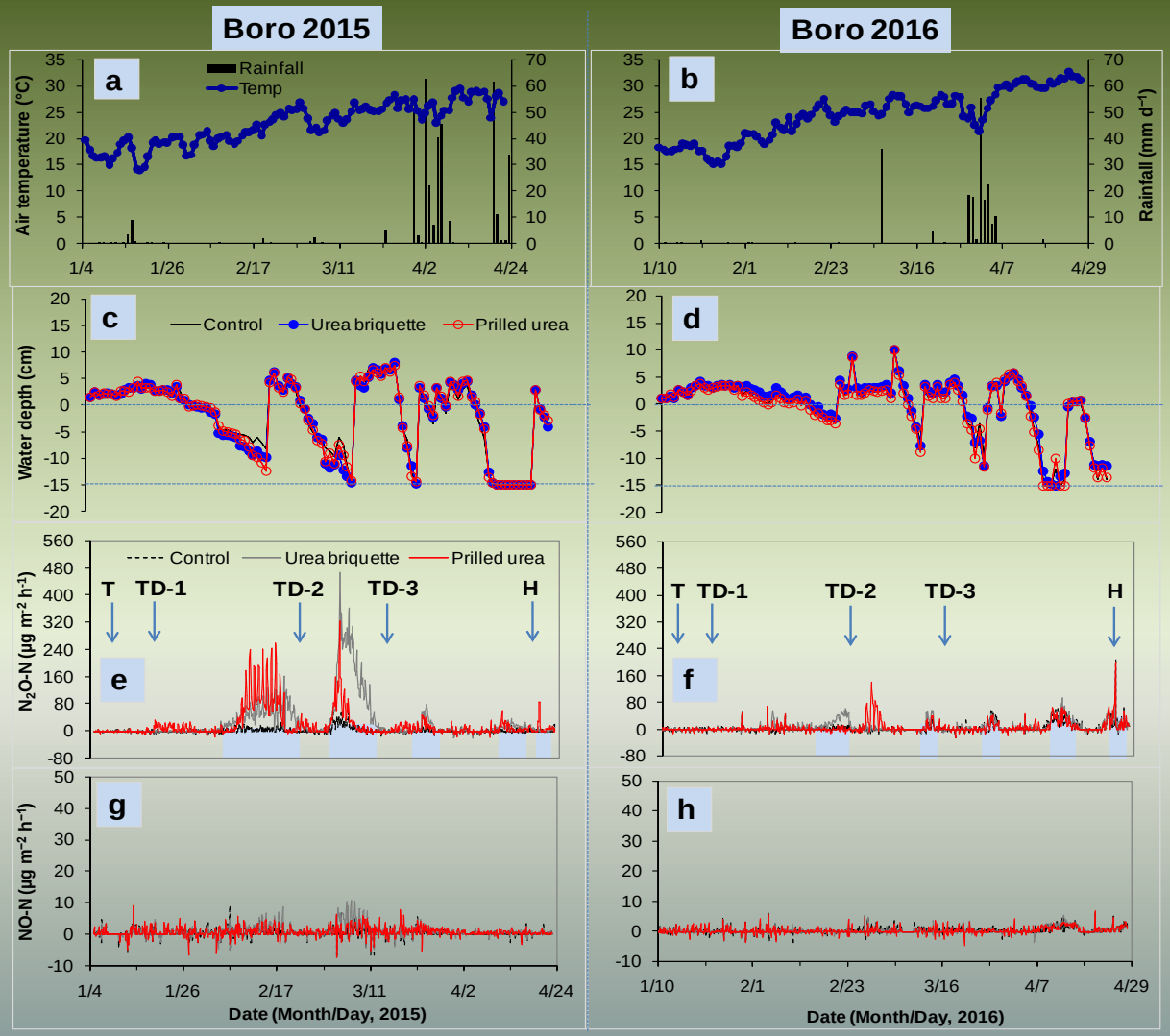

Fig. Nitrous and nitric oxides emission rates, floodwater depth, air temperature and rainfall under AWD condition during Boro 2015 and Boro 2016 seasons at BRRI, Gazipur. T, TD-1, TD-2, TD-3 and H correspond to transplanting, first, second and third topdressing and harvesting, respectively. Shaded area indicates the drying period.