Alternate Wetting and Drying (AWD) Irrigation Reduces Greenhouse Gas Emissions Over Conventional Practices

- **Dr. S.M. Mofijul Islam** Senior Scientific Officer
- **Md. Nayeem Ahmed** Senior Scientific Officer
- **Mahmuda Akter** Scientific Officer
- **Dr. Md. Rafiqul Islam** Chief Scientific Officer & Head

Soil Science Division
Bangladesh Rice Research Institute
Gazipur-1701

INTRODUCTION

The atmospheric concentration of anthropogenic greenhouse gases (GHGs) has been increasing substantially since pre-industrial era. The concentration of carbon dioxide (CO_2) has increased from a pre-industrial era of an annual average of 280 to 401 ppm, methane (CH_4) from 715 to 1800 ppb, and nitrous oxide (N_2O) from 270 to 328 ppb in 2015 (EPA, 2016). However, CH_4 and N_2O is major GHG in rice field and their contribution in global warming potential (GWP) is 28 and 265 times more potent than CO_2 on a 100-year time horizon (IPCC, 2014).

Boro (dry) is the main rice growing season, which covers about 4.5 m ha of the total rice growing area in BD (BBS, 2017) and it is completely dependent on irrigation. Hence groundwater table is depleting due to excessive withdrawl of irrigation water for Boro rice cultivation, upstream human activities and due to climate change, which leads to increasing additional pumping cost to farmers for irrigation. Hence, appropriate water management practices such as AWD irrigation might be an effective strategy to mitigate global warming potential and save 4-5 numbers of irrigation in Boro season.

OBJECTIVES

1. Quantification of GHG emission from rice field under AWD and continuous standing water conditions
2. Developing efficient fertilizer and water management technologies that increase crop productivity with reduced negative environmental impacts.

MATERIALS AND METHODS

The field experiment was conducted in BRRI farm, Gazipur during Boro 2017-18 and 2018-19 under two water regimes continuous standing water (CSW) and AWD irrigation. Four treatments under each water regimes were tested for GHG measurement in both seasons (Table 1).

A closed chamber technique (Fig. 1) was used to collect each gas samples at 3 intervals (0, 15, 30 min) to measure CH_4 and N_2O emissions. The fluxes of CH_4 and N_2O were measured using a gas chromatograph (Shimadzu GC-2014, Japan). Fluxes (mg $m^{-2}d^{-1}$) were determined from the slope of the linear regression model.

Figure 1. Gas sampling using closed chamber technique

RESULTS

Effects of water regimes on greenhouse gas emissions. AWD irrigation significantly reduced seasonal CH_4 fluxes in all treatments compared to CSW conditions in both seasons (Fig. 2), but the magnitude of cumulative CH_4 emission was relatively small in Boro 2019 over Boro 2018 season. In contrast, AWD irrigation increased cumulative seasonal N_2O emissions in all treatments, but the magnitude was relatively higher in deep placement of urea briquette (UB) treatment (Fig. 3).

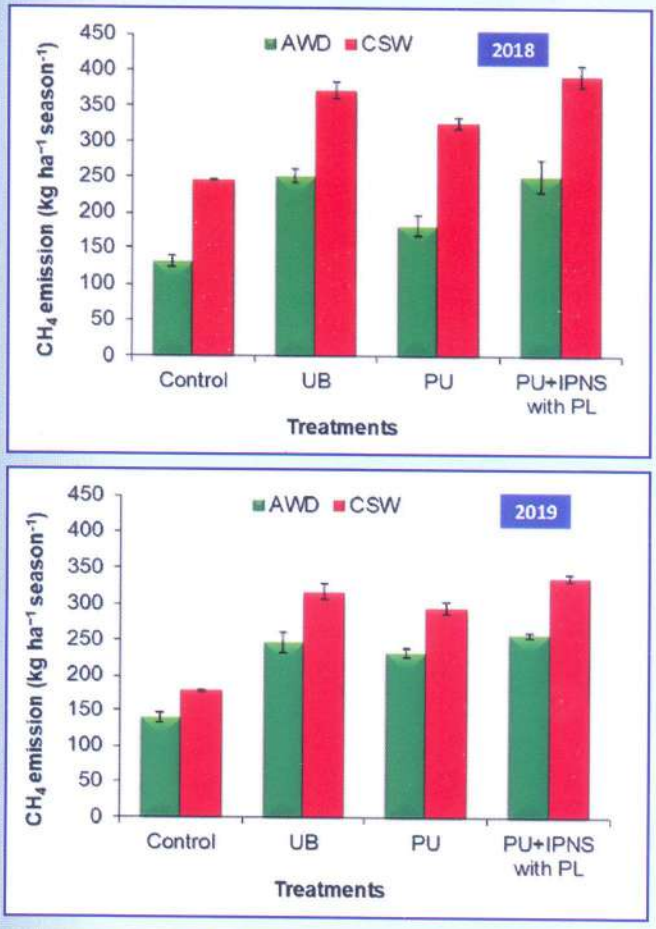
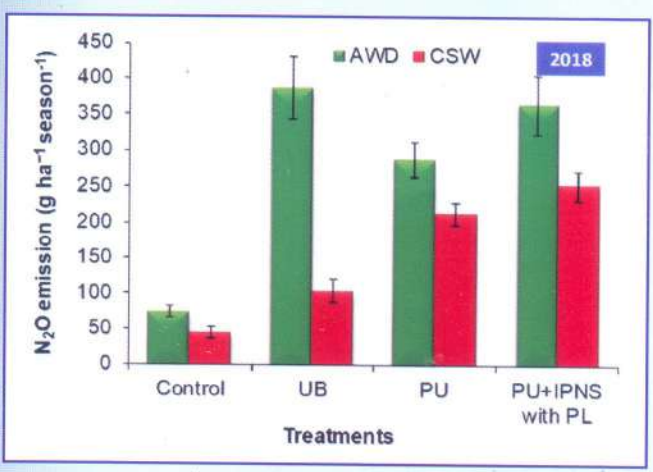


Figure 2. Effects of water management on cumulative CH_4 emission during Boro season at BRRI farm, Gazipur.



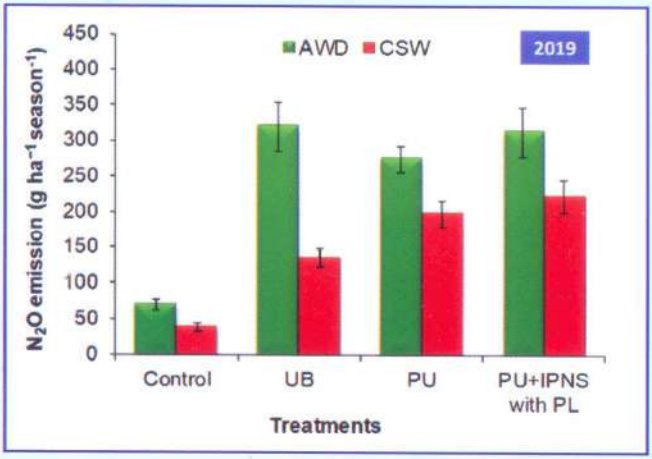


Figure 3. Effects of water management on cumulative N_2O emission during Boro season at BRRI farm,

Global warming potential (GWP). AWD irrigation significantly reduced GWP in all treatments compared to CSW condition (Table 1). Across the treatment, AWD irrigation reduced about 35% GWP over CSW condition in Boro season (Table 1).

Table 1. Effects of water management on global warming potential in Boro season

Treatment	GWP (kg CO_2 eq. ha^{-1} $season^{-1}$)		% GWP reduction in AWD over CSW
	AWD	CSW	
Control	3698	5591	34
Urea briquette deep placement	7327	10425	30
Prilled Urea (PU)	5296	9168	42
PU+IPNS with poultry litter	7195	11080	35
Average	**5879**	**9391**	**35**

Carbon credit claim. Across the treatment, AWD technology supports to claim ca. 48,974 million Tk in Boro season per year due to reduction of CO_2 equivalent GHG in 100% rice cultivated area (4.475 m ha) of Bangladesh (Table 2).

Table 2. Effects of water management on carbon credit claim

Treatment	GWP (kg CO_2 eq. ha^{-1} $season^{-1}$)		GWP reduction (ton CO_2 eq. ha^{-1}) due to AWD	Total claimable amount (Million TK)
	AWD	CSW		
Urea briquette deep placement	7327	10425	3.098	41,931
Prilled Urea (PU)	5296	9168	3.872	52,407
PU+IPNS with poultry litter	7195	11080	3.885	52,583
Average	**6606**	**10224**	**3.618**	**48,974**

CONCLUSION

AWD irrigation could be a potential option for mitigating GWP along with saving irrigation water in rice cultivation without any yield penalty. Moreover, if we apply this technology at least in 25% of total rice cultivated area, we can claim about 12243 million Tk in Boro season per year. However, long-term field experiments need for the reduction of GWP under different agro-ecological zones with various environmental conditions and soil types, which represent the total scenario of Bangladesh for developing national GHG inventory.

For more information, please contact

Divisional Head
Soil Science Division
Bangladesh Rice Research Institute
Gazipur-1701
Mobile: 01725-395749
E-mail: rafiqbrri@yahoo.com
web: www.brri.gov.bd

Publication No. 292
Year 2020
2000 Copy