Knowledge 1a: Current initiatives and activities in the region on reducing emissions and increasing resilience in rice landscapes

Assessing the feasibility of GHG mitigation through water saving techniques (AWD) in irrigated rice fields in southeast Asian countries (FYs 2013-2017 funded by MAFF of Japan)

Outline of the MIRSA-2 project

Kazunori Minamikawa (JIRCAS, Japan)

MIRSA-2 project funded by MAFF of Japan

Completed 5-year international research project to support the activities of GRA Paddy Rice Research Group.
➔Asia sub-group meeting will be held on DAY3 afternoon.

Project goal was to develop improved water management based on AWD that can always reduce CH_4+N_2O emission from irrigated rice paddies in Asian countries.

1. Field demonstration of AWD feasibility in SEA countries
➔This session's topic

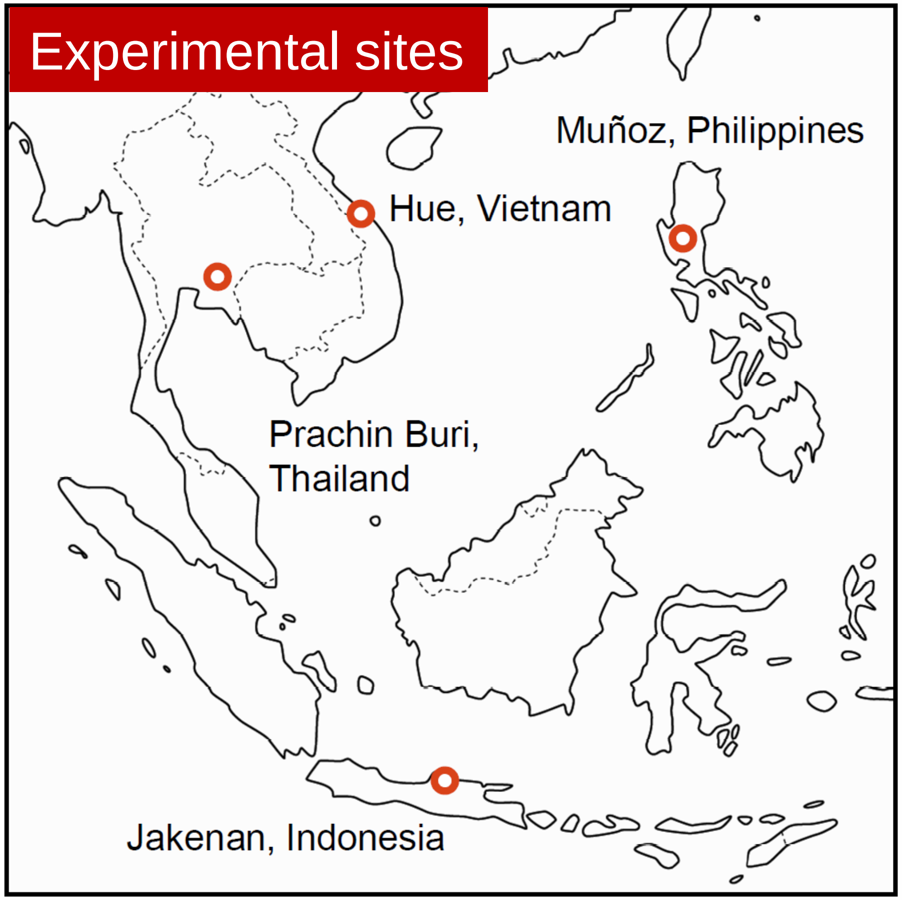
2. Development of MRV guidelines for paddy water mngm
➔My presentation's topic on DAY2 morning

MIRSA

GRA, Global Research Alliance on Agricultural Greenhouse Gases
AWD, Alternate Wetting and Drying
MRV, Monitoring, Reporting and Verification

Participating countries and institutes

- **Vietnam**, Hue University of Agriculture and Forestry
- **Thailand**, The Joint Graduate School of Energy and Environment, KMUTT
- **Philippines**, Philippine Rice Research Institute and International Rice Research Institute
- **Indonesia**, Indonesian Agricultural Environment Research Institute
- **Japan**, National Agriculture and Food Research Organization



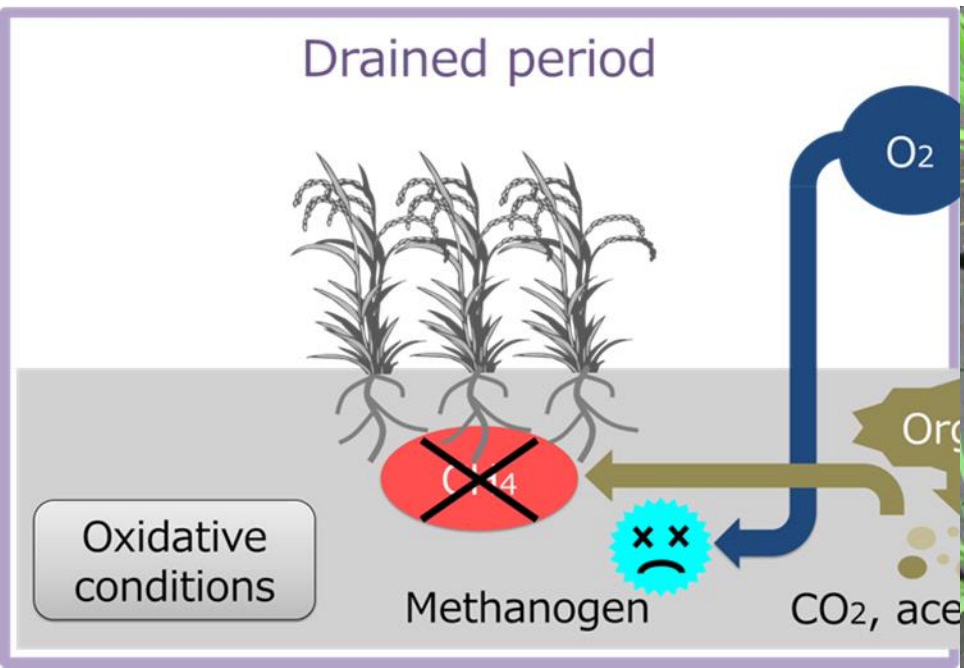
Benefits of AWD

Originally developed and being extended by the International Rice Research Institute since 1990's.

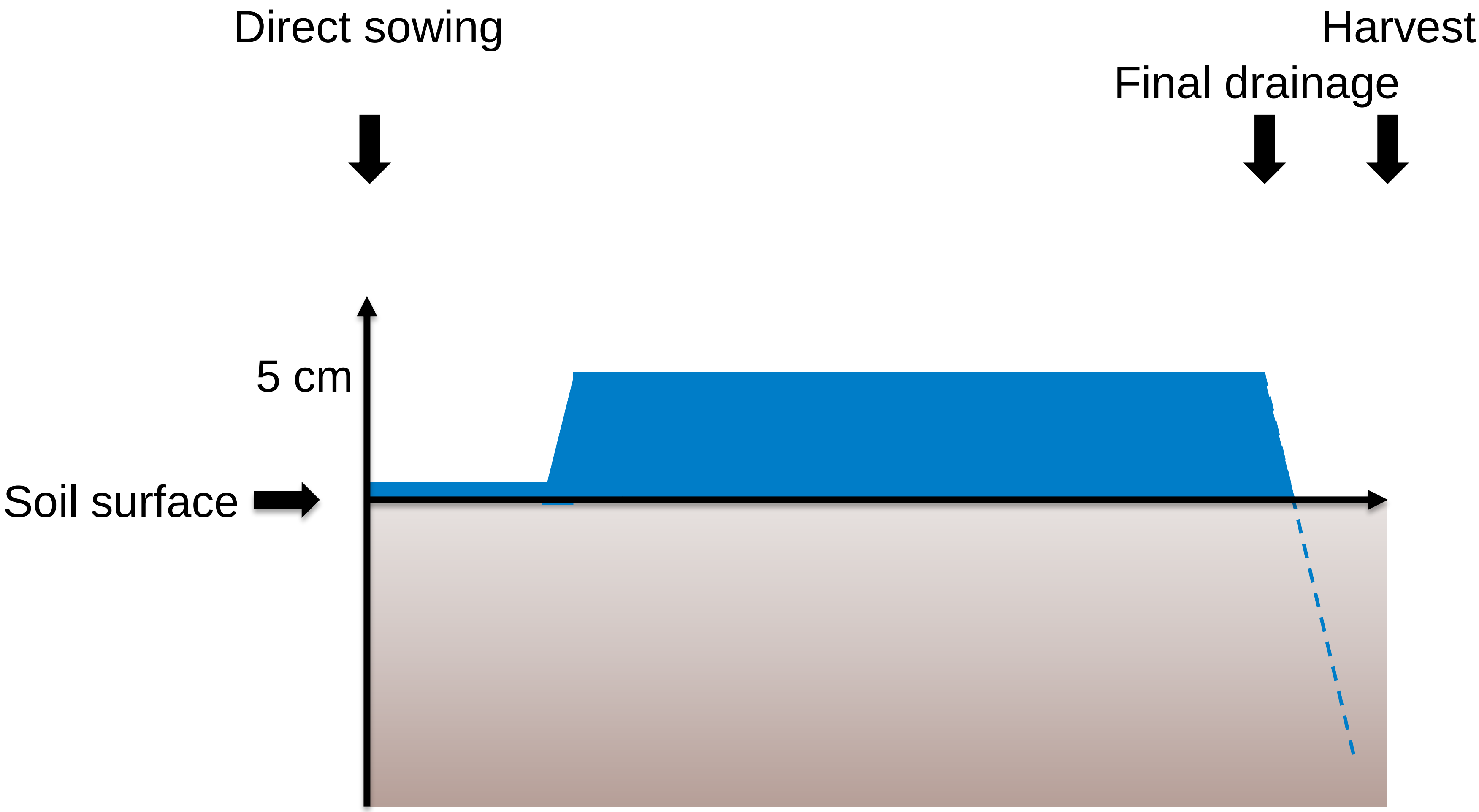
- Water saving for farmers
- CH_4 emission reduction for global environment
- Arsenic pollution control for local environment
- Negative possibilities: water stress, Cadmium pollution, N loss (N_2O), soil fertility, labor, etc.

CH_4 emission from rice paddies

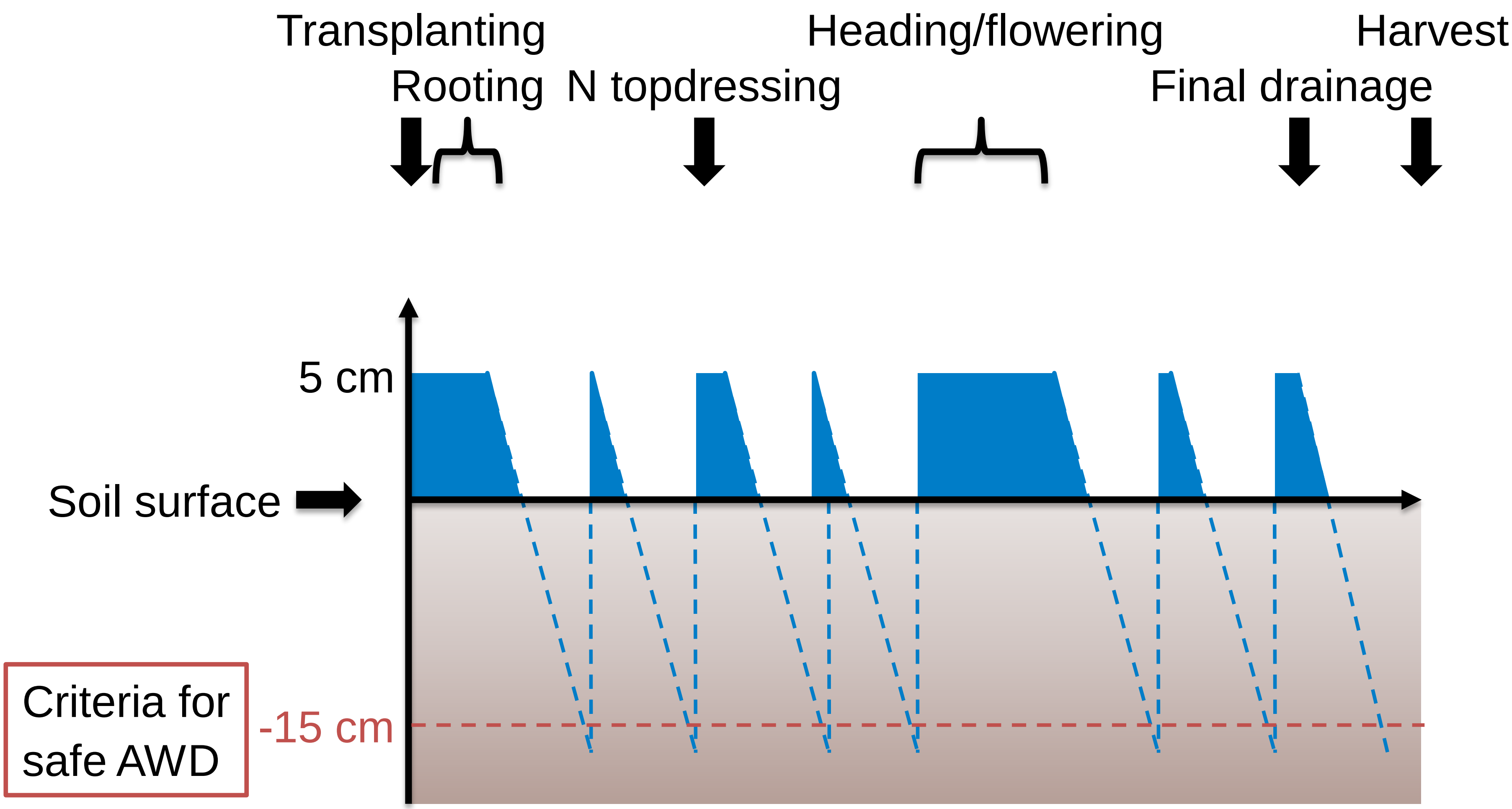
- Produced from easily decomposable organic C by microbes under strictly reductive soil conditions and emitted mainly through rice plants.
- Water management creates oxidative soil conditions, and thus effectively reduces CH_4 production and emission.



Shape of continuous flooding



Shape of AWD



Recommendation: Keep flooding to meet rice's water demand in rooting and heading/flowering stages and to improve N-use efficiency after N topdressing.

Shared experimental protocol

Objectives

- To assess the feasibility of AWD in irrigated rice paddies
- To derive the emission factor and scaling factor for CH_4 and N_2O

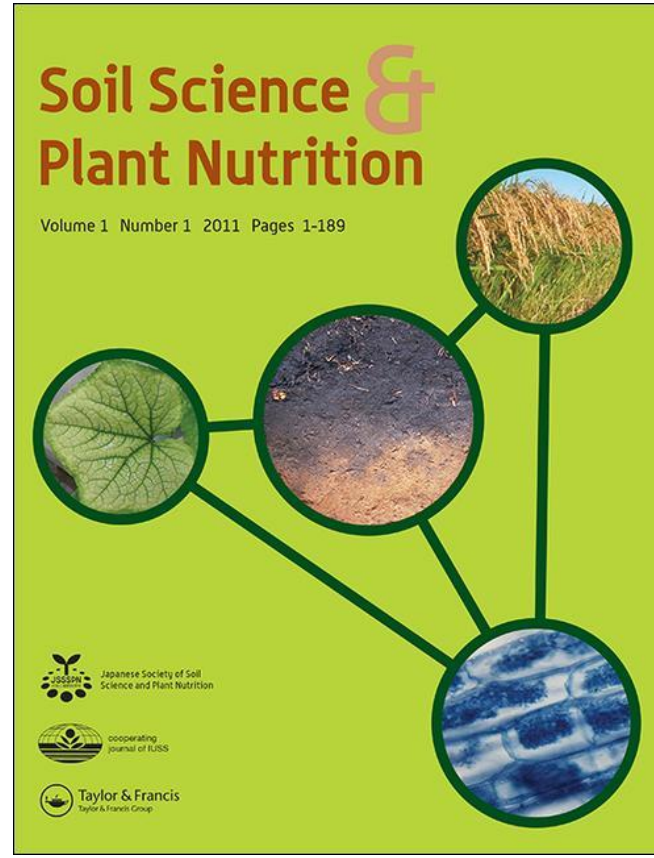
Setting

- 6 crops in 3 years: both dry and wet seasons (rice double cropping)
- 3 water management practices: continuous flooding, safe AWD, and site-specific AWD (explained later)
- Manual closed chamber method

An output from MIRSA-2 project

Five papers (four field papers and one synthesis paper) published from *Soil Science and Plant Nutrition* in 2018.

Open access



Synthesis of the four field studies

SOIL SCIENCE AND PLANT NUTRITION, 2018
VOL. 64, NO. 1, 2–13
https://doi.org/10.1080/00380768.2017.1409602

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Site-specific feasibility of alternate wetting and drying as a greenhouse gas mitigation option in irrigated rice fields in Southeast Asia: a synthesis

Agnes Tirol-Padre[a], Kazunori Minamikawa[b], Takeshi Tokida[b], Reiner Wassmann[a,c] and Kazuyuki Yagi[b]

Kazunori Minamikawa (JIRCAS, Japan)

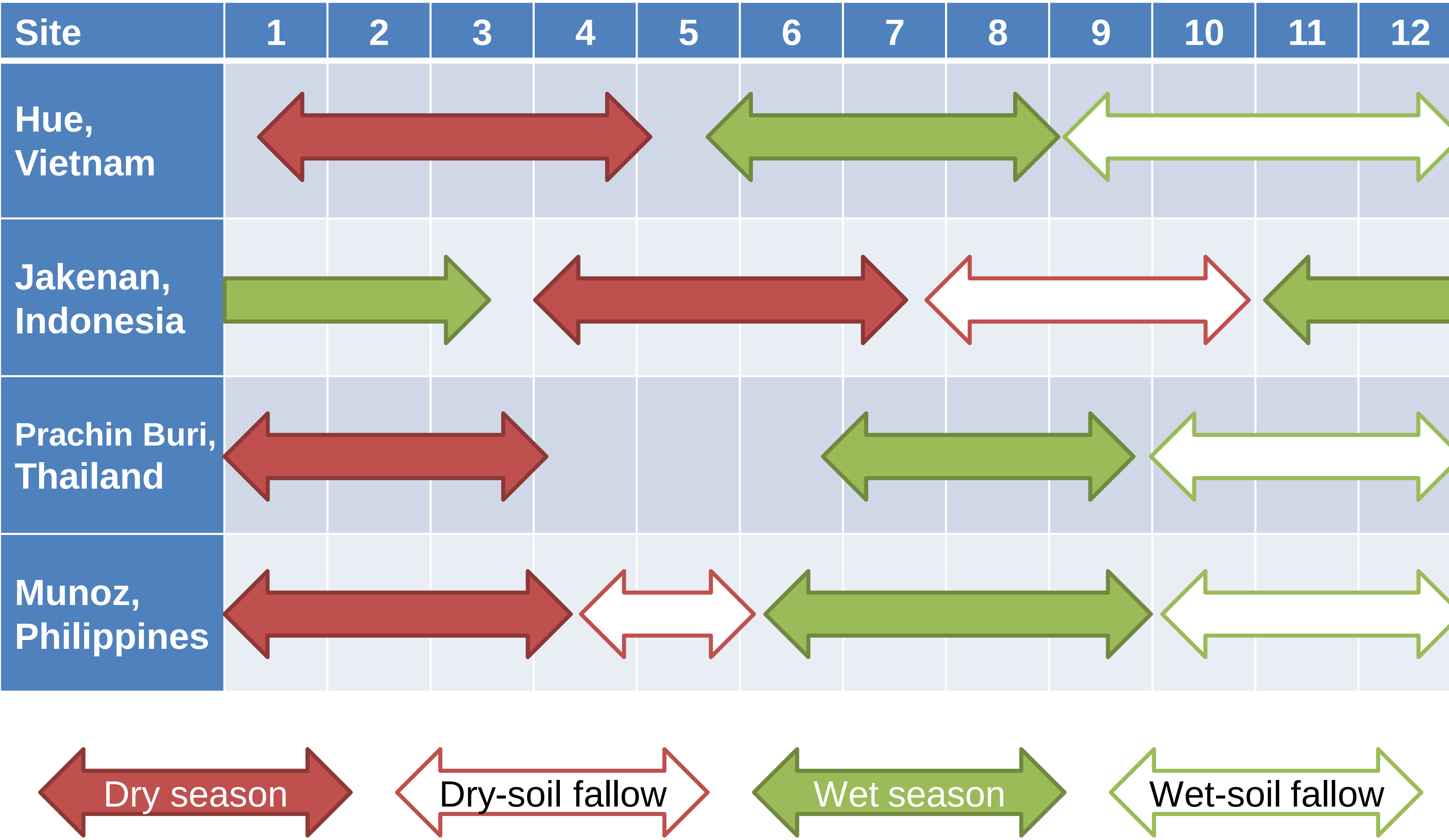
JIRCAS

Agronomic practices

	Hue, Vietnam	Jakenan, Indonesia	Prachin Buri, Thailand	Munoz, Philippines
Rice variety	HT1	Cisadane	RD41	NSIC Rc238
Growth days	96–120	107–132	88–98	81–98
Crop establishment	Wet direct sowing	Wet: Direct sowing Dry: Transplanting	Pre-germinated seed sowing	Transplanting
Chemical N*	92–120	120	70	90–120
Chemical P*	72	60	37.5	40
Chemical K*	62–78	90	37.5	40
Organic amendment	Microbial organic fertilizer	Farmyard manure	None	None
Straw mngm	Removal	Removal	Removal	Removal

* N (kg N ha^{-1} $season^{-1}$); P (kg P_2O_5 ha^{-1} $season^{-1}$); K (kg K_2O ha^{-1} $season^{-1}$).

Crop calendar

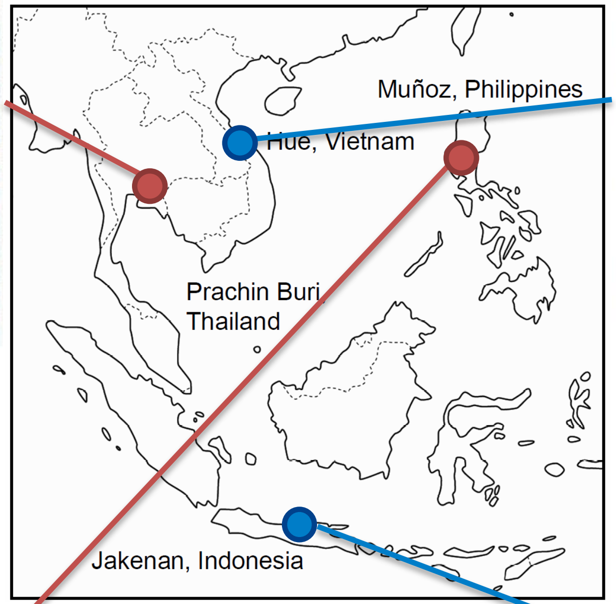


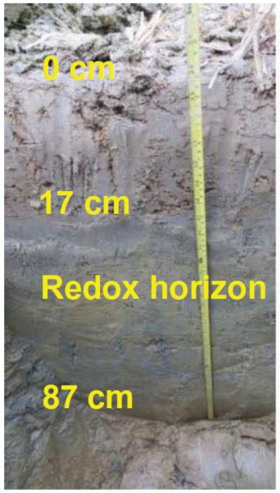
Soil properties

CLAYEY SOILS

LOAMY SOILS

Prachin Buri, Thailand
USDA: Vertic Endoaquepts





Hue, Vietnam
FAO: Ustic Epiaquert
USDA: Eutric Vertisol

Munoz, Philippines
FAO: Dystric Fluvisols
USDA: Typic Endoaquepts

Jakenan, Indonesia
USDA: Aeric Endoaquepts

ANOVA statistics

*** 0.1%, ** 1%, * 5%, † 10%

	CH_4	N_2O	GWP	Grain yield	Yield-scaled GWP	Water use
Site (S)	***	***	***	***	***	***
Dry or wet season (DW)	**	ns	**	ns	**	***
Water mgmt (WM)	***	ns	**	ns	ns	***
S×DW	***	***	***	***	***	***
S × WM	ns	ns	*	ns	†	***
DW × WM	ns	ns	ns	ns	ns	ns
S × DW×WM	ns	ns	ns	ns	ns	*

No trade-off

No negative effect

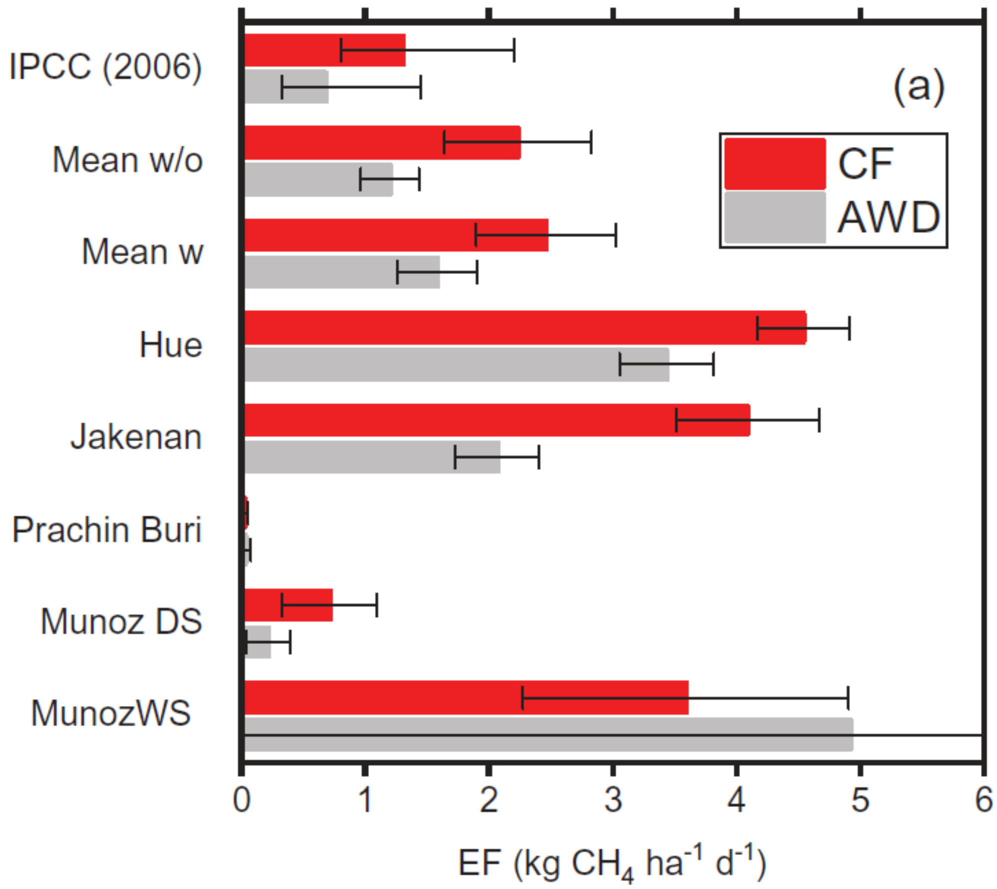
Saving

Mitigation

Mitigation

Inter-site variation

CH_4 Emission Factor

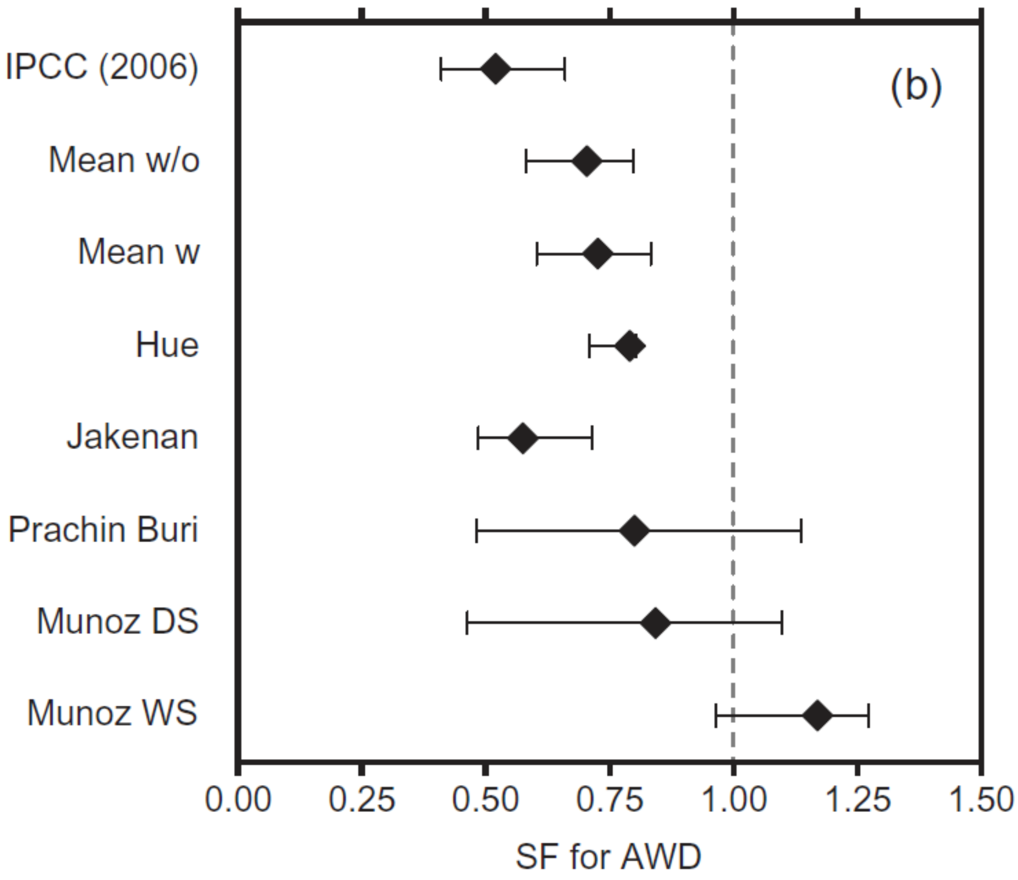


Notes

- IPCC's baseline EFs for continuous flooding (CF) and multiple aeration
- Weighted mean ± bootstrapped 95%CI
- Mean w/o & w: without & with Munoz Philippines WS
- Safe AWD and site-specific AWD combined
- DS, dry season; WS, wet season

Large spatio-temporal variation due to different environmental and agronomic setting.

CH_4 Scaling Factor for AWD

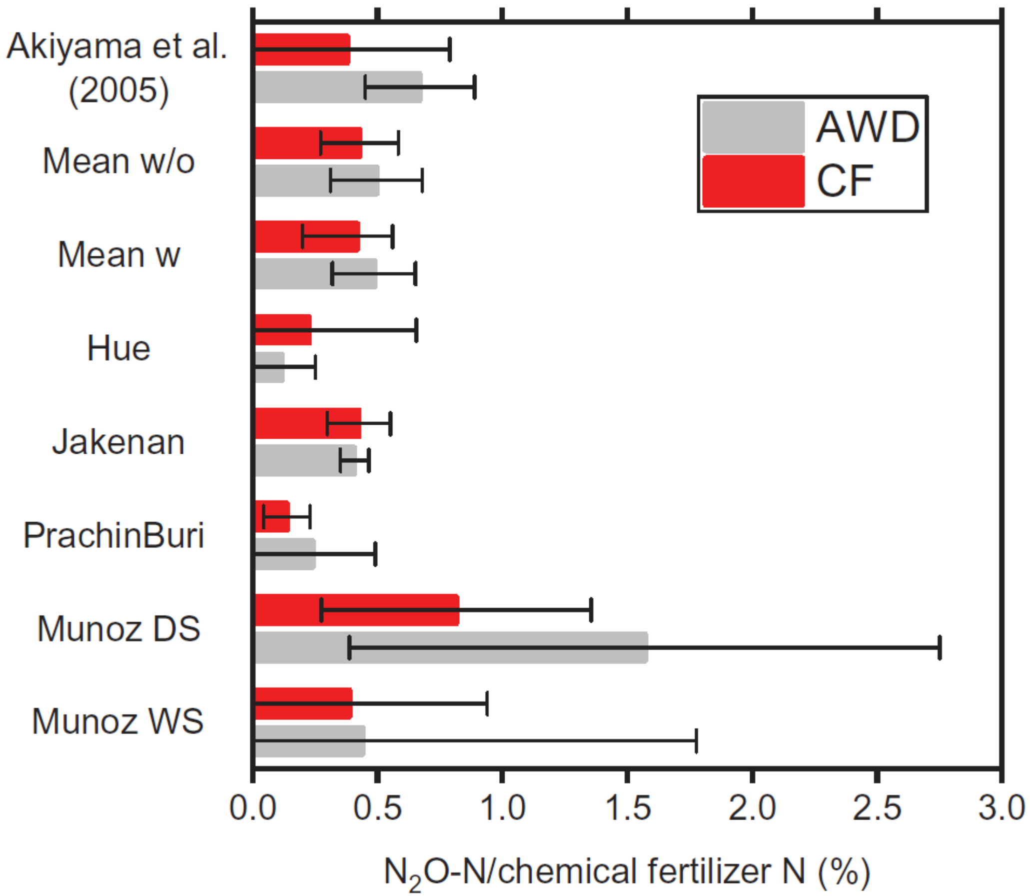


Notes

- IPCC's SF for multiple aeration
- Weighted mean ± bootstrapped 95%CI
- Mean w/o & w: without & with Munoz Philippines WS
- Safe AWD and site-specific AWD combined
- DS, dry season; WS, wet season

Lower CH_4 mitigation effect by AWD than IPCC's default SF due to varying weather conditions during the field experiment.

N_2O-N / chemical fertilizer-N



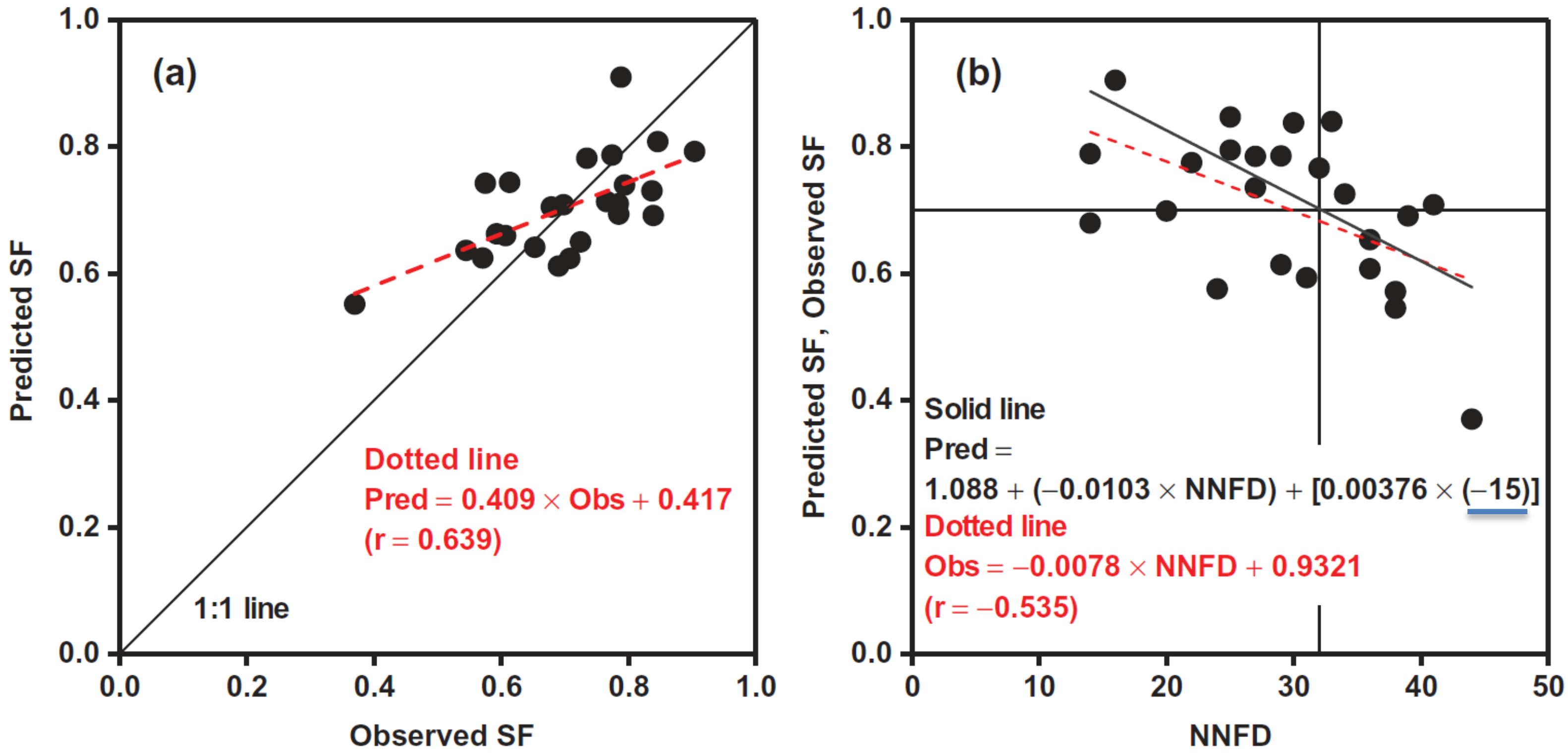
Notes

- Akiyama et al.'s values for CF and midseason drainage
- Weighted mean ± 95%CI
- Mean w/o & w: without & with Munoz Philippines WS
- Safe AWD and site-specific AWD combined
- DS, dry season; WS, wet season

Mean ratios comparable to Akiyama et al.'s values.

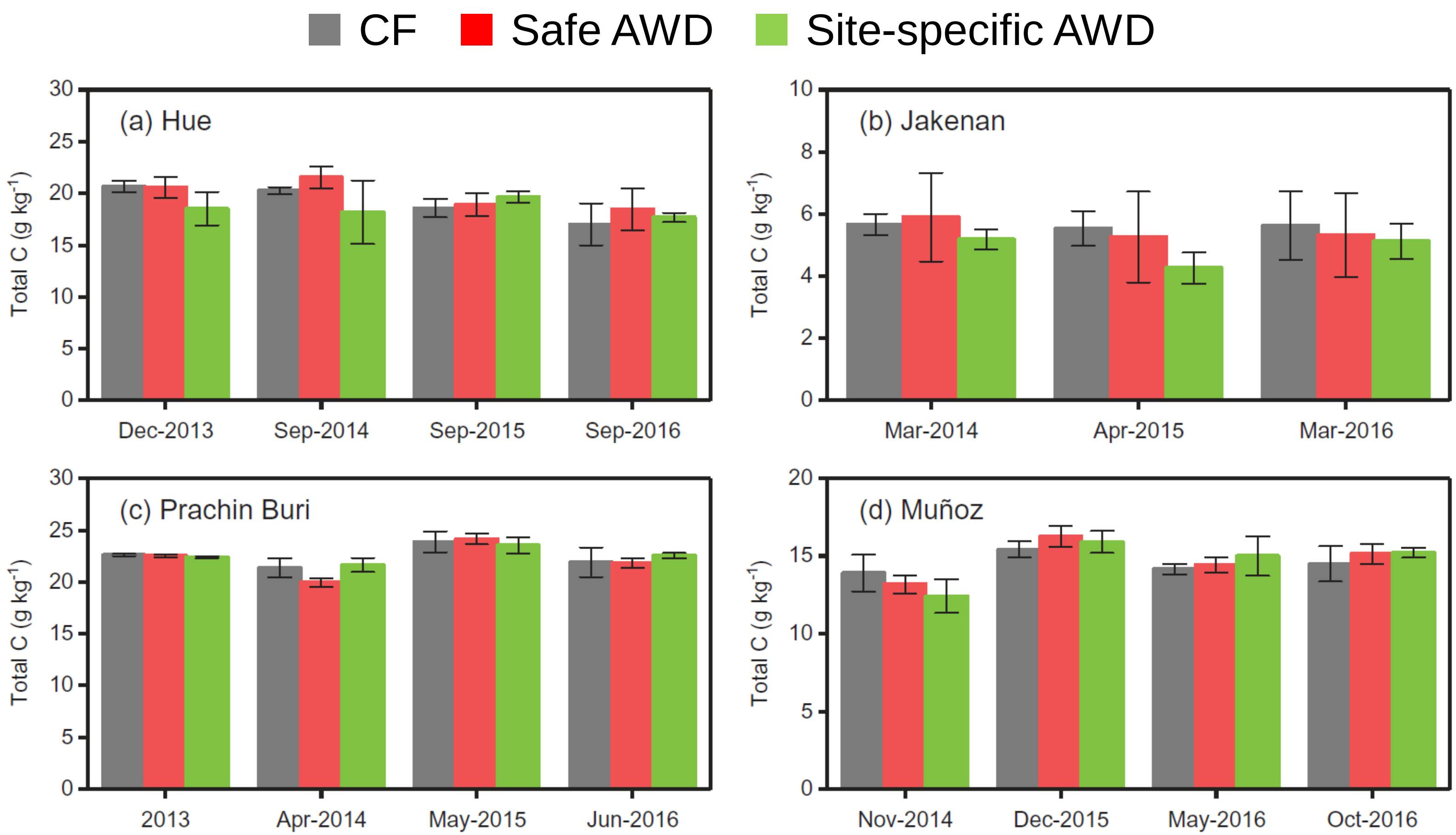
Munoz's high N_2O due to N topdressing during drained period.

The severer drainage, the lower CH_4 in loam



- Combination of the minimum surface water level (MinWL, cm) and the number of non-flooded days (NNFD) explained 41% of the variability in SFs for AWD in loamy soils (i.e., Vietnam and Indonesia).
- When MinWL = -15 cm (i.e., criteria for safe AWD), 30% reduction in CH_4 emission can be achieved if NNFD ≥ 32 based on the predicted SF.

No negative effect on SOC decomposition



Total C and N concentrations in 0-20 cm soil layer did not significantly differ among 3 water management practices through the 3-year experiment at each of the four sites.

Summary

- The mean CH_4 SF for AWD was 0.69 (95%CI: 0.61-0.77) among the four sites (➔ lower mitigation potential than IPCC's SF of 0.52).
- In Vietnam and Indonesia sites, AWD was effective even in wet seasons, both of which had a loamy soil.
- In Thailand and Philippines sites, AWD was unsuitable in wet seasons due to the frequent rainfall and the slow water percolation in clayey soils.
- The results indicate that IPCC's SF may only be applied to irrigated rice fields where surface water level is controllable for a substantial period.
- This synthesis underscores the importance of practical feasibility and appropriate timing of water management in successful GHG reductions by AWD.

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