Year-round implementation of alternate wetting and drying across three cropping seasons improves farmers' benefits and reduces greenhouse gas emissions

The Mekong Delta, located in southern Vietnam, is the country's largest paddy rice cropping region. Recently, the area planted with rice has been expanding due to the cultivation of three-season crops. Increasing rice acreage is an effective means of meeting food demand and maintaining or improving farmers' incomes. However, intensive rice cropping system is increasing water demand and greenhouse gas (GHG) emissions.

In rice paddies, the soil becomes anaerobic (without oxygen) and the anaerobic microorganisms produce methane (CH_4), which exacerbates climate change. An irrigation technique called alternate wetting and drying (AWD) is one of the promising technologies that have been developed to reduce irrigation water consumption. This technique supplies oxygen to the soil and reduces CH_4 emissions.

Based on the MeaDRI Strategy and the Global Methane Pledge, JIRCAS is carrying out research about the impact of AWD in the Asia-Monsoon region to facilitate further dissemination. A comprehensive evaluation on the impact of AWD on farmer benefits and GHG emissions, and the merits of year-round implementation across three cropping seasons, has not been done. Therefore, the main objective of this study is to evaluate the impact of year-round AWD implementation on life cycle greenhouse gas (LC-GHG) emissions and farmers' benefits using survey data in 2019-2020 from An Giang Province in the Mekong Delta region of Vietnam. Using the life cycle assessment method, LC-GHG emissions were calculated by summing up emissions from agricultural material production, rice cultivation, harvesting, and rice straw management (Fig. 2).

The results of this study showed that farmers who implemented AWD for three cropping seasons increased their annual financial benefits by 6% compared to farmers who did not implement AWD (Fig. 3). It also revealed that farmers who implement AWD could reduce annual LC-GHG emissions by 38% for the entire year (Fig. 4). Based on these results, this study recommends implementing AWD throughout the year in An Giang Province if irrigation and drainage systems are available.

The implementation of year-round AWD is a co-benefit agricultural system that both increases farmers' benefits and reduces environmental impacts from agriculture, and is expected to be a promising mitigation and adaptation measure for climate change in the Asia-Monsoon region. The results obtained in this study can be used as supporting data for the effectiveness of year-round AWD implementation.

(A. Leon, T. Izumi)

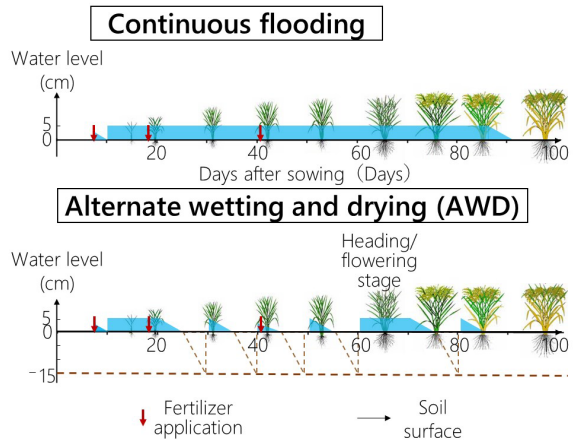

Fig. 1. An example of conventional water management (continuous flooding) and alternate wetting and drying (AWD) during a cropping season

Under AWD, the paddy soil is reflooded to a depth of 5 cm after several days of drying when the water table reaches approximately 15 cm below the soil surface, except for ten days from 10 to 20 days after seeding and during the fertilizer application period and flowering period.

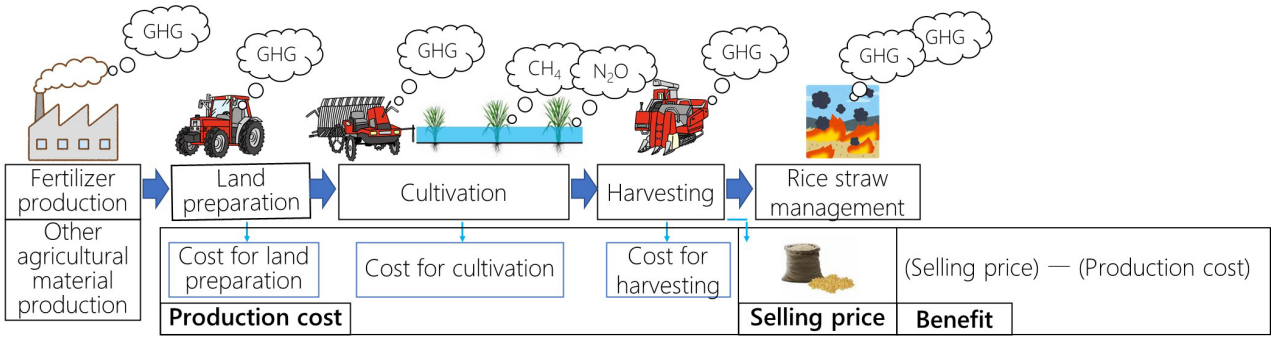

Fig. 2. Life cycle greenhouse gas (LC-GHG) emissions and benefits

LC-GHG is the sum of emissions from agricultural material production to harvesting/rice straw management.

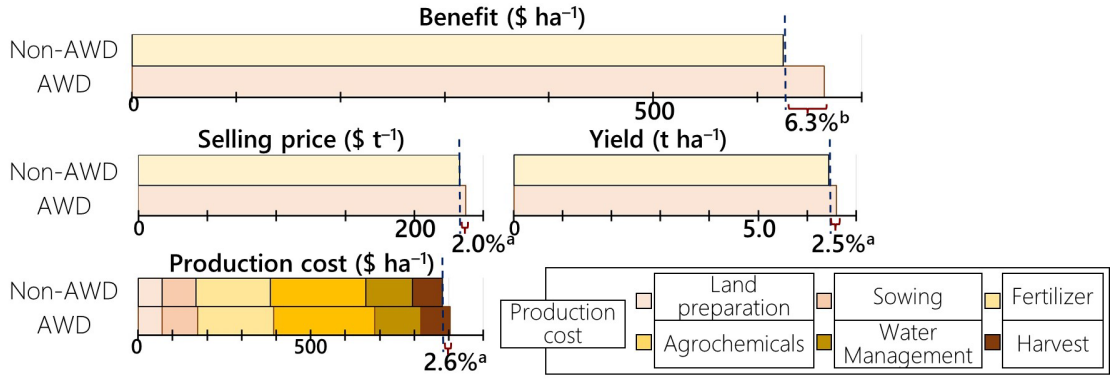

Fig. 3. Benefit, selling price, yield and production cost of non-AWD and AWD farmers

a: $p<0.05$, b: $p<0.056$; n: Number of fields analyzed (501 non-AWD farmers, 535 AWD farmers)

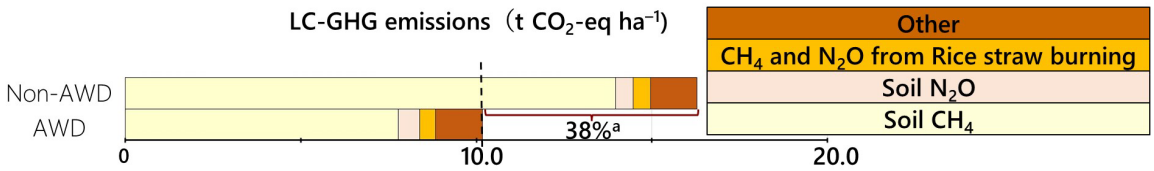

Fig. 4. Life cycle greenhouse gas (LC-GHG) emissions of non-AWD and AWD farmers

a: $p<0.05$; n: Number of fields analyzed (470 non-AWD farmers, 515 AWD farmers)

Reference: Leon and Izumi (2022) *Journal of Cleaner Production* 354: 131621.

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