Research of Water-Saving System for Paddy Field in Thai Highland Communities

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INTRODUCTION

In Thai highlands, Karen tribe members comprise 42% of the total hill tribe people. The Karen people grow rice for livelihood and food security, but rice yields are often low and insufficient to meet needs for household consumption. Irrigation water is limited in highland areas, but the hill tribe farmers often cultivate flooded rice because they believe that rice plants grow better in flooded soils and because flooding helps to manage weeds.

Previous research has shown that non-flooded rice can improve the efficiency of water use and stabilize yields in highland areas (Li, 2001; Bouman and Tuong, 2001; Bouman1 *et al.*, 2002). Rice production in non-flooded soils might also be more environmentally sound as non-flooded soils emit less methane than flooded soils, thereby reducing the production of powerful greenhouse gasses. Some of the advantages observed in non-flooded rice cultivation include more vigorous plant growth, more efficient fertilizer use, and less pest and disease incidence (Parthasarathi *et al.,* 2012).

Research was conducted in cooperation with farmers and incorporated into the farmers' normal management of their paddy fields so the research process could promote two-way learning.

OBJECTIVES

1) To investigate the volume of water usage by rice fields under the non-flooded and flooded soil condition in highland paddy fields.
2) To monitor the emission of greenhouse gases from rice fields between non-flooded and flooded soil in highland paddy fields.

METHODOLOGY

The experiment was conducted at Phrao district, Chiang Mai province (at 800 mMSL) during 2014 and 2015. Local variety San-Pa-Tong1 was grown from transplanted seedlings and harvested at 97 DAT (137 DAS)

Two treatments were imposed:

1) Flooded, which used irrigation water to maintain water depth from 3 to 10 cm;
2) Non-flooded, which used irrigation to maintain a water depth of 3 cm until 3 weeks after transplanting, followed by alternate drying and rewetting when irrigation was applied flood soils to 5 cm.
3) Alternate wet and drying cycle was conducted twice during the tillering stage (27-40 DAT and 48-61 DAT) by draining the water out of field to the level below rice roots for 14 days and then irrigating the field back 5 cm water level.

RESULTS

In 2014; local variety San-Pa-Tong1 yielded 3.9 Mg ha^{-1} when grown under non-flooded conditions and 3.6 Mg ha^{-1} under flooded conditions. The irrigated water volume of non-flooded was 4.5 ML ha^{-1} and 6.9 ML ha^{-1} under flooded soil condition, which is a 35% water savings in the non-flooded treatment.

In 2015, the non-flooded treatment yielded 4.6 Mg ha^{-1} and the flooded treatment yielded 4.1 Mg ha^{-1}. The non-flooded treatment used 9.0 ML ha^{-1} of irrigation water, which was 56% less water than the flooded treatment, which used 20.5 ML ha^{-1}. San-Pa-Tong1 grown under non-flooded conditions yield 11% more than when grown under continuous flooding.

Table 1 Daily and cumulative CH_4 and N_2O, Global warming potential (GWP), and Effective CH_4 and N_2O emission reductions .

Variable	Unit	Non-flooded	flooded
Average daily CH_4 emission	mg $CH_4/m^2/day$	17.98±1.37	43.12±5.51
Cumulative CH_4 emission	kg CH_4 /ha	12.20	50.41
GWP_{CH4}	kg CO_2 eq/ha	256.15	1,058.60
Effective CH_4 emission and GWP_{CH4} reduction	% per crop	75.80	-
Average daily N_2O emission rate	mg $N_2O/m^2/day$	3.82±0.51	2.99±0.39
Cumulative N_2O emission	kg N_2O/ha	2.69	3.13
GWP_{N2O}	kg CO_2 eq/ha	832.58	969.41
Effective N_2O emission and GWP_{N2O} reduction	% per crop	14.11	-
GWP_{total}	kg CO_2 eq/ha	1,208.10	2,028.02
Total GWP_{total} reduction	% per crop	46.32	-

Non-flooded

Flooded

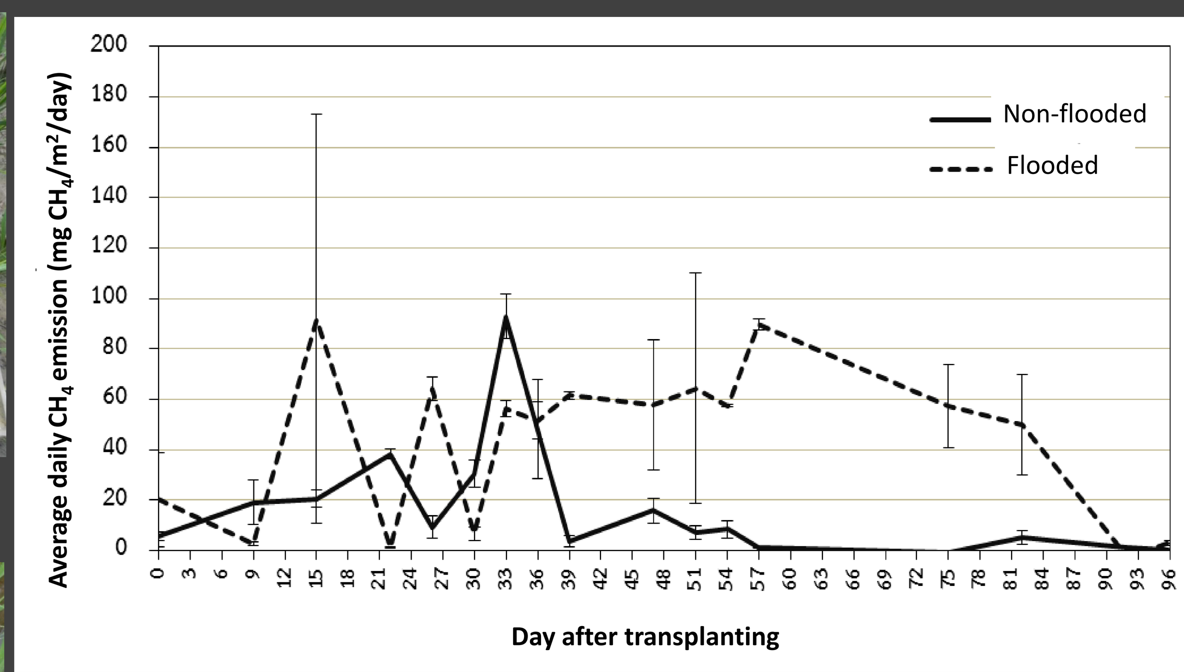

Fig. 1 Average daily CH_4 emission throughout the 96-day cultivation period

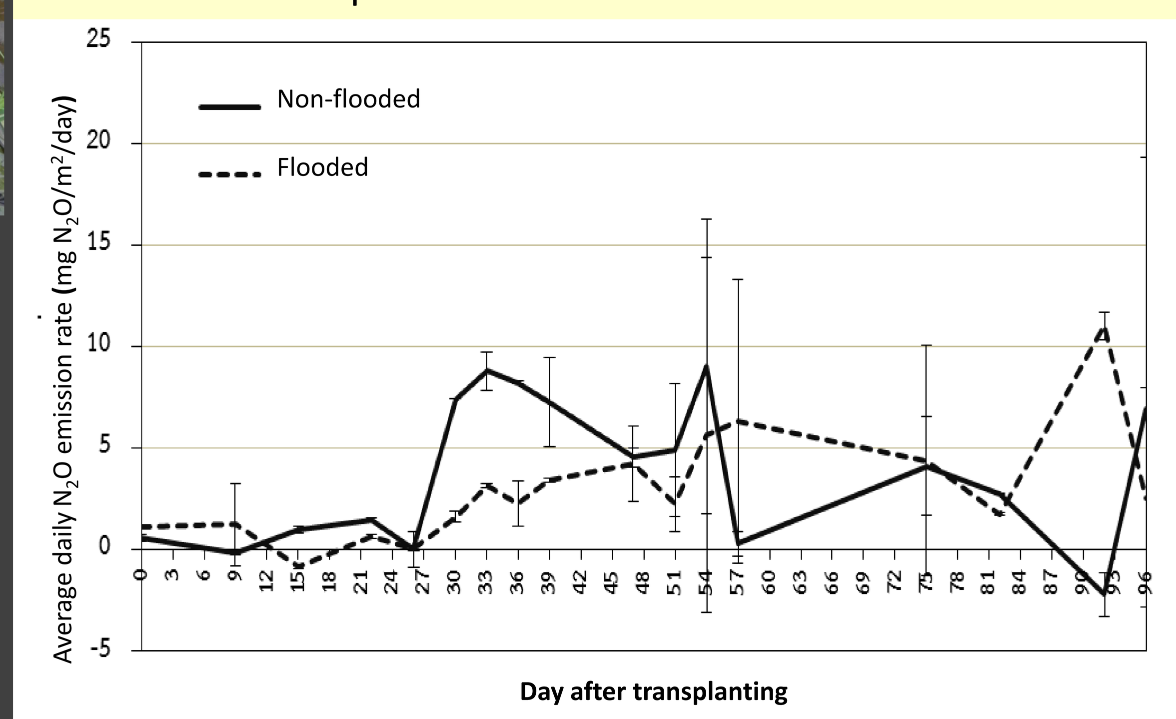

Fig. 2 Average daily N_2O emission rate throughout the 96-day cultivation period

Cumulative methane emissions in the non-flooded treatment were 12.2 kg CH_4 ha^{-1}, which was 75% less than the 50.4 kg CH_4 ha^{-1} emitted in the flooded treatment. Cumulative nitrous oxide emissions were 2.69 kg N_2O ha^{-1} in the non-flooded treatment, which was 14% less than the 3.13 kg N_2O ha^{-1} emitted in the flooded treatment. Combined, non-flooded fields produced 46% less carbon equivalents than the flooded treatment (Table 1, Fig. 1 and Fig.2).

CONCLUSIONS

The results indicated that the water-saving system of alternate wetting and drying cycles had multiple benefits. It reduced methane and nitrous oxide emissions from rice terraces as well as increasing water usage efficiency and rice yields. If farmers adopt this water-saving system of non-flooded rice production in highland areas, they can conserve water for production of economic crops.

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