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Final Report

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Title: Varietal effects of five different rice varieties on diurnal Methane fluxes at different rice development stages

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Report

About a field trial

Conducted in the Mekong Delta, Vietnam

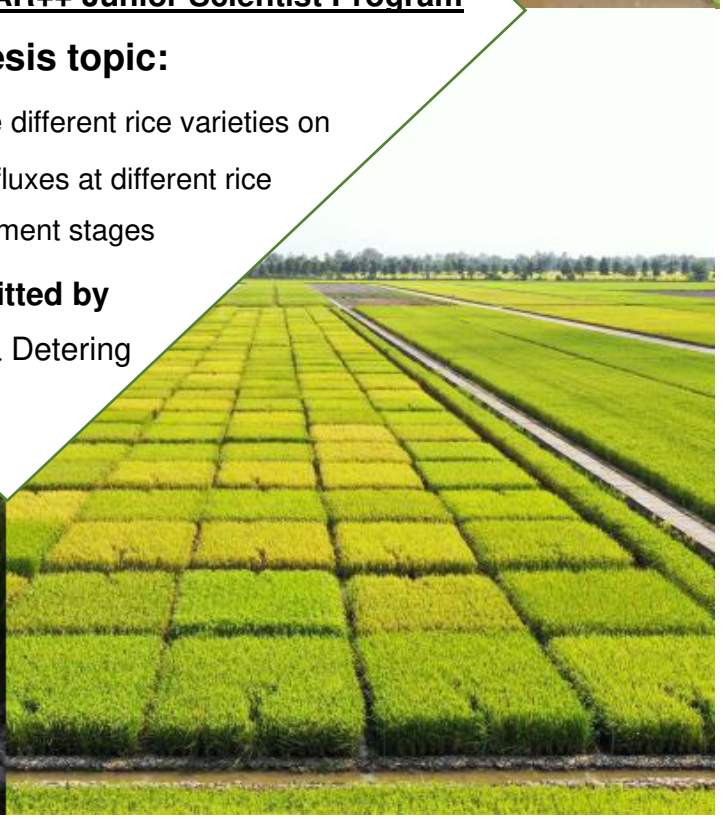
Supported by : ATSAF-CGIAR++ Junior Scientist Program

Master thesis topic:

Varietal effects of five different rice varieties on diurnal Methane fluxes at different rice development stages

Submitted by

Theresa Detering



Agricultural sciences of the University of Hohenheim

Introduction

According to the global climate risk index 2018, Germany was among the three most affected countries of weather-related loss events (storms, floods, heatwaves, etc.) of the world (Eckstein et al., 2019). Signs of climate change have reached Germany as well as any other continent or region and can no longer be ignored. A growing scarcity of water, as well as increasing salt intrusions and salinity gradients, threaten farmer's livelihood and food security worldwide. These facts and the urge to make a change encouraged my decision to dedicate my master thesis work to a climate-relevant topic. Supported by the ATSAF-CGIAR++ Junior Scientist Program, I conducted my practical field experiment from 01.12.2019 to 26.03.2020 in the Mekong River Delta, Vietnam. I examined the varietal effects of five different rice varieties on diurnal Methane fluxes at different rice development stages, at a research field provided by the Dinh Thanh Agricultural Research Center that belongs to the Loc Troi Group, which is located in An Giang province. For greenhouse gas sampling, I used a manually operated, closed chamber method, as described by Minamikawa et al. (2015). The Methane emissions of rice paddy fields underlie typical diurnal emissions (Weller et al. 2015). One of my main objectives will be the development of a correction factor that can be used to minimize the effects of diurnal variations in CH_4 emissions to improve the estimation of daily and seasonal emissions.

Supervision

The following persons supervise my master´s thesis, including the field experiment in collaboration with the Loc Troi Group[1] in Vietnam:

Prof. Dr. Asch - Head of the Department of Water Stress Management for Crops in the Tropics and Subtropics at the Hans-Ruthenberg-Institut of the Agricultural Faculty of the University of Hohenheim.

Dr. Reiner Wassmann - Climate change specialist at the International Rice Research Institute (IRRI). The head of the Climate Unit, in charge of the coordination of rice research as well as climate change programs.

MSc. Vo Thi Bach Thuong **-** a PhD candidate at the Institute of Agricultural Sciences in the Tropics of the University of Hohenheim. She holds a master in Environmental

[1] https://loctroi.vn/gioi-thieu

Science from the University of the Philippines Los Banos (UPLB), and a bachelor's degree in Biotechnology.

Company description – Loc Troi Group

The An Giang Plant Protection Service Company (AGPPS) was founded on November 30th, 1993 by the peoples´ committee of An Giang Province and started with only a few, small facilities in the field of plant protection chemical supply. The company quickly expanded its branches, built new factories, and established a variety of sectors. They entered the field of seed research, rice breeding, and trading with the construction of a new seed research and production center (Historical story - The Loc Troi Group 2020). In October 2012, the Dinh Thanh Agricultural Research Center (DTARC) was launched (Fig. 1). The first privately run, large-scale agricultural research center (in collaboration with Syngenta) with close connections to corporations, institutes, and domestic as well as international schools and universities. The DTARC is mainly focusing on scientific research, prioritizing the development of new high-yielding, high-quality rice varieties for export markets, and human resource development (Zhou und Babu 2015). The An Giang Plant Protection Service Company officially changed its name to Loc Troi Group on August 23, 2015. Over the years, the company has developed into the leading manufacturer and supplier of agricultural products and services, particularly in the rice sector, in Vietnam. Loc Troi is cooperating with about 40.000 farmers households and has spread over the whole Mekong Delta region (Historical story - The Loc Troi Group 2020).

Figure 1 Dinh Thanh Agricultural Research Center, An Giang Province (https://naticons.com/projects/trung-tam-nghien-cuu-nong-nghiep-dinh-thanh-dtarc/)

Work description

The range of tasks I accomplished during my stay in Vietnam covers the following parts:

1. Preparation of the experiment
2. Continuous communication and discussion with supervisors and Loc Troi Group representatives
3. Implementation of the field trial
4. Ongoing problem solving, time management and organization
5. Initial data evaluation

A meeting held on the 25th of November at the Dinh Thanh Agricultural Research Center marked the starting point of our project. Therefore, representatives of the Loc Troi Group, University of Hohenheim, Kien Giang University, and the International Rice Research Institute (IRRI) joint a discussion concerning the experiment. Among the participants were:

From DTARC site: Dr. Bui Thi Duong Khuyeu (director), MSc. Tran Nguyen Ha Trang (Vice director), MSc. Nguyen Van Hoa (Head of the Application Research unit); From University of Hohenheim site: Prof. Dr. Folkard Asch, Dr. Jörn Germer, MSc. Vo Thi Bach Thuong, MSc. Van Hong Nguyen, BSc. Theresa Detering, Dr. Duong Van Nha, and Dr. Reiner Wassman. We clarified project details and coordinated tasks during the conversation. It was arranged that the field experiment would be conducted during the dry season of 2019/2020 (December to March) at the experimental site of the DTARC owned by the Lộc Trời Group (LTG) located in Định Thành commune, Thoại Sơn District, An Giang Province, South Vietnam. Therefore, the University of Hohenheim rented a field of about 5000 m^2 and paid for additional labour and fieldworkers to help us complete the experiment.

Mrs. Vo and I spent our time in the following few days to find an apartment in a middle-sized city called Long Xuyen. A town that served us as a place to live and work for the next four months. Its proximity to the research station and its location on the campus of An Giang University made it a perfect fit. Our work at the research station started on 5th December with the preparations of the seedbeds. We sowed 20 different rice varieties in separate plots and carefully covered them with coconut mulch to protect the soil from high water losses and the seedlings from the intense sunlight. While the

seeds germinated and seedlings grew, field preparation and the building of irrigation and drainage canals were completed. Mrs. Vo and I commissioned the construction of the access bridges and bought the rest of the missing items for our field experiment.

The access bridges, respectively 1 m long wooden planks with a metal frame at each end, were prepared to minimize soil disturbance while sampling. Those could be placed on four poles made of eucalyptus wood set up in each plot. Twelve days after seeding, we helped to cut and distribute the rice seedlings into the right plots. The field layout was arranged as a randomized split block design with three replications consisting of 180 plots with a 4 x 5 m dimension. The main factor (block) was water management (CF, AWD, SSC), while the sub-factor comprises 20 rice varieties. The whole field from above is illustrated in Figure 2.

The Main-plots were three water treatments:

(1) continuous flooding (CF): fully irrigated - maintaining at least 5 cm of ponded water in the plots;

(2) Alternate wetting and drying (AWD): plots were subjected to a periodic drying and re-flooding irrigation schedule, when the water level decrease to a level of about -20 cm under the soil surface, plots were irrigated again. To monitor the water depth, we inserted 'field water tubes' made of 40 cm long PVC plastic, and

(3) Soil saturated moisture (SSM): to maintain soil saturation, the SSM plots were flooded with irrigation water to a depth of about four cm and then drained to a saturated level.

Figure 2 Field trial from above at the end of the growing period with 180 plots (Loc Troi Group)

Over the next three days, we assisted the transplanting of 15-day old seedlings at a distance of 20 x 20 cm. To prepare for the greenhouse gas sampling, we inserted 180 aluminium bases about 10 cm into the soil at a location representing the average plant density of a given plot. We installed these bases at least a day before sample collection and left them in the field throughout the growth period. The gas collection chambers: rectangular chambers fabricated from plexiglass with a height of 94 cm were equipped with a thermometer, a sampling port and a battery-operated fan installed inside (details described by Minamikawa et al., 2015)). On 23 December, one day before our first sampling, we prepared all 15 chambers and trained workers in our gas sampling procedure.

We collected gas samples three times a week during the mid-morning from 8 am till 12 pm. In one sampling round, we used 10 to 15 chambers with the help of three to four workers, each in charge of one to four chambers (Fig. 3).

Figure 3 Sampling with 15 chambers

The samples were collected at 0, 15, and 30 minutes after chamber closure. For gas collection, we used a 60 ml syringe fitted with a stopcock attached via a valve to the gas sampling port. Figure 4 and 5 show the whole experimental setup.

Figure 4 Chamber and access bridge

Figure 5 Set up: Thermometer, battery, vials and syringe

After five times flushing the plastic tube connected to the port, with air out of the chamber, we extracted the gas samples and subsequently inserted them with a needle into an evacuated glass vial, which was provided by IRRI. We stored the vials at the LTG guest house, where we rented a room and afterwards sent them for analysis. The samples were analyzed with an SRI 8610C gas chromatograph (GC) at IRRI lab in Los Banos, Philippines. In addition to the data on greenhouse gas emissions, I recorded soil moisture and Leaf Area Index (LAI)(Fig.6 and 7). To monitor the soil moisture over the whole growing season in 45 plots, I utilized a PR2/6 capacity sensor. Also, I used an LAI Plant Canopy analyser to measure the LAI of rice at different development stages.

Figure 6 Soil moisture measurement with the PR2/6 probe

Figure 7 LAI measurements

On 16.03.2020, we started harvesting the first varieties, Mrs. Vo carried out the last gas sampling on 24 March and completed the experiment on 26 March 2020 with the harvest of the last rice plants.

Apart from the sampling, a range of other tasks emerged. To name just a few: weekly pre- and debriefing of the experiment with Mrs. Vo, restructuring of workflows, organization of additional measurements, communication and problem solving with my supervisors, data input and evaluation, etc.

Although the field experiment was not yet finalized, I had to leave the Dinh Thanh Agricultural Research Centre on 19 March and return to Germany. The flight situation had worsened due to the outbreak of the SARS-CoV-2 virus and no improvement was to be expected soon.

Final considerations

Implementing the practical part of my master's thesis abroad gave me the opportunity to enhance a wide range of skills in a completely new and professional working environment. My time in Vietnam allowed me to develop my personal strengths, improve my self-confidence and often made me push past my limits. When I arrived in Vietnam, I quickly realized that one of the most challenging issues that I had to face would be the actual communication with the Vietnamese, as only a few spoke English. Therefore, I am very grateful for the help and patience of Mrs. Vo and google translate, who have done their best to establish a basic understanding. Over my stay, I had the chance to gain incredible experience, both professional and personal. Most of all, I improved my organization and communication skills. I dealt with difficult situations, had to prove my flexibility and worked in a team on problem-solving strategies. I got inspired by an entirely new culture and different ways to live. Even though it was not always easy, I am very thankful for all the memorable moments I had and for the people I met.

Acknowledgments

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