Evaluation and mitigation of emissions of CH4 and N2O from Agroecosystems in monsoon Asia

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http://www.niaes.affrc.go.jp/globalrs/magews/index.htm

Agriculture contributes to about 40% of respective global emissions of methane (CH4) and nitrous oxide (N2O). As it is described in the IPCC assessment reports, CH4 and N2O emissions from agricultural sources can be reduced significantly through improved technologies of agronomic practices, animal nutrition, and animal waste management. Although, various candidates of mitigation technologies for CH4 and N2O emissions from agricultural sources have been proposed and discussed, there are gaps in knowledge that: 1) There are large uncertainty in quantitative evaluation of each technology due to the diversity of climate and ecosystems. 2) Most of the proposed technologies focus mainly on the mitigation efficiency of CH4 and N2O emissions, but little attention has been paid on the feasibility and the trade-offs with economy and production. 3) Developing the methods to scaling up the point data to regional or global evaluation is needed to estimate the mitigation effects of the technologies. We focus on bridging the gaps in knowledge for CH4 and N2O mitigation in agricultural sector and aims to make a quantitative evaluation of the mitigation technologies for the emissions from cultivated land and animal industry in monsoon Asian countries.

The activities of the research project are based on field measurements of GHG exchange, laboratory experiments, GHG database compilation, and modeling, aiming at making a quantitative evaluation of the mitigation technologies for the emissions from cultivated land and animal industry in monsoon Asian countries. The studies have been developed to address scientifically and socially important questions related to the environmental impacts of agriculture. Experimental sites are set up in various part of monsoon Asian countries. At each site, various mitigation options are tested and the effects are quantitatively estimated. Those options include water and organic matter management in rice fields, fertilizer management in various crop lands, improvement of animal diet for animals, and animal waste management.

Results in rice fields showed that replacing rice straw incorporation with composting manure and improving mid-season drainage practices reduced the emissions by 49-63% and 22-89%, respectively, compared with each corresponding control treatment. Installing underground draining pipes in paddy fields also showed very large potential of the mitigation. Field and laboratory experiments for mitigating N2O emissions from fertilized agricultural fields demonstrated the effectiveness of applying manure and slow release fertilizer as nitrogen fertilizer. The experiment in a Chinese maize field showed that applying slow release fertilizer reduced N2O emissions by 58-67% compared with conventional urea application.

The emission database of rice fields in Asian countries were compiled and analyzed using a linear mixed model. The result showed a baseline emission factor for CH4 to be 130 mg m-2 day-1, together with the effects of various controlling factors. Database analysis of N2O emissions from Asian fertilized fields extracted significant controlling factors, as well as the uncertainty due to rain fall events. An emission factor for N2O emissions from paddy fields was estimated to be 0.31%. Process-based and mixed process-empirical models were validated by applying observation data of CH4 emissions from paddy fields.

CH4 production from various species of cattle and buffalo in Southeast Asia were estimated to be 5-9 MJ-CH4/100MJ-Gross energy intake. It was demonstrated that CH4 production from Ongole crossbred young bulls could be reduced from 225 to 161 g-CH4/kg-daily live weight gain by increasing concentrate feeding frequency. Nitrogen excretion of pig urine was reduced by 25% by balancing amino acid composition in the feed, which resulted in reduction of N2O emissions during the manure management processes.