Mitigation of Greenhouse Gas Emissions From Agricultural Lands by Optimizing Nitrogen and Carbon Cycles

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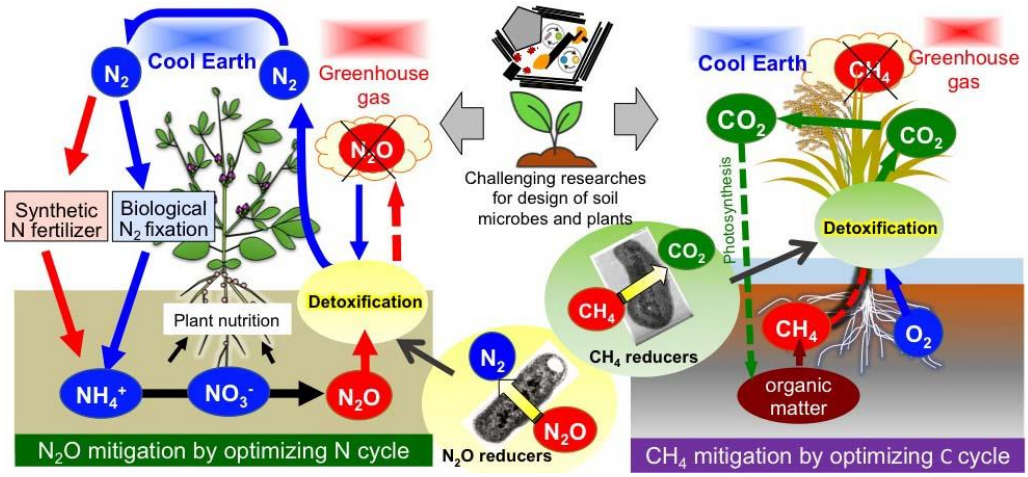
Summary

We aim to develop innovative technologies to mitigate greenhouse gases from agricultural soil by 2030, and to achieve an 80% reduction of greenhouse gas emissions from agricultural soil by 2050, as a part of Moonshot Goal 4 ‘Cool Earth’ and ‘Clean Earth’.

Nitrous oxide (N_2O) is a powerful greenhouse gas with a global warming potential of 265. Agriculture accounts for 59% of global anthropogenic N_2O emissions. Paddy rice fields are also a source of methane (CH_4) emissions, accounting for 11% of the global anthropogenic CH_4 emissions. Thus, it is essential to mitigation of greenhouse gases from agriculture. In the natural nitrogen cycle, atmospheric nitrogen gas (N_2) is fixed by microorganisms and converted into reactive nitrogen such as ammonia and nitrate. Reactive nitrogen circulate ecosystem and eventually return to the atmosphere as nitrogen gas (N_2). Although modern agriculture has succeeded to increase food production using chemical nitrogen fertilizers, N_2O emission from agricultural soil is increasing rapidly. In this research project, we will develop mitigation technologies by using soil microorganisms regarding nitrogen and carbon cycles.

We found that some rhizobia can reduce N_2O to N_2. Methanotrophs are known to oxidize CH_4 to CO_2. We will maximize such microbial processes at the field scale. However, the biggest challenge is that artificially inoculated microorganisms are usually eliminated due to the robustness of the soil ecosystem. Therefore, by integrating the latest research methods and activities of young researchers in different disciplines, we unveil the whole pictures of soil microorganism world, and reorganize plant-microbe relationships in order to achieve our goal.



Targets by 2030

FY2022: We will isolate soil microbes with higher N_2O-reducing and CH_4-oxidizing activities and develop new nitrification and denitrification inhibitors.

FY2024: We will attain (i) 30% reduction of N_2O emission in field tests by inoculation with higher N_2O-reducing rhizobia in legumes, (ii) 80% reduction of N_2O emission in laboratory by application of new nitrification and denitrification inhibitors. We will also develop technologies to increase CH_4-oxidizing activity in paddy rice.

FY2029: We will attain 80% reduction of N_2O and CH_4 emissions from experimental agricultural fields by combining multiple greenhouse gas reduction technologies for microbes, crops and nitrogen control agents.

Implementation

Tohoku University, National Agriculture and Food Research Organization (NARO), The University of Tokyo