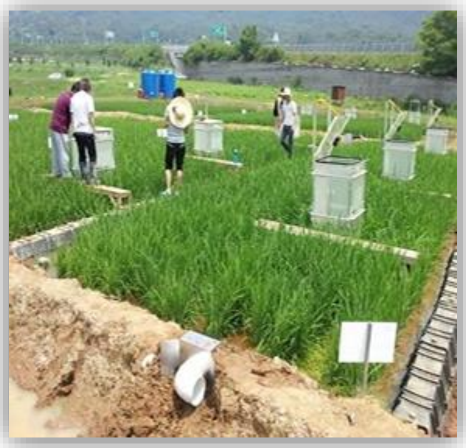
SRI and Climate Change Mitigation

Flooded rice paddies are a major source of methane (CH_4), a greenhouse gas (GHG) that is roughly 30 times more potent than carbon dioxide (CO_2), the main GHG that contributes to global warming and to climate change. Rice paddies contribute about 15-20% of the total methane emissions that human activities currently generate and propel into the atmosphere [1, 2]. Methane is produced by methane-fermenting anaerobic bacteria known as methanogens. Control of the abundance and activity of these bacteria is a crucial factor among several factors for reducing the amounts of this gas coming from paddy rice production.

Methanogens can only survive and colonize soil that is kept in steady, continuous anaerobic condition. Upon contact with oxygen molecules if the soil is made aerobic by alternating drainage and irrigation or by plowing that turns over the soil, these bacteria immediately die off and cannot easily recover, even when anaerobic conditions are re-created by re-flooding, i.e., irrigation. Methane emissions can definitely be reduced if paddy soil is regularly drained and aerated.

The management methods of the System of Rice Intensification (SRI), by creating aerobic soil conditions through shallow and intermittent irrigation or alternate wetting and drying (AWD), bring about mostly aerobic soil conditions that sharply reduce methane emissions. Research has shown that intermittent paddy irrigation by SRI or AWD reduced methane emissions by between 22% and 64% [3,4,5,6,7,8].

It must also be taken into account that creating aerobic soil conditions in rice paddies can increase the potential for production and emission of nitrous oxide (N_2O). This is a GHG about 300 times more potent than CO_2. N_2O currently contributes about 5% to GHG emissions compared to 10% from CH_4 and 82% from CO_2. Research has shown that with SRI crop and water management, which includes AWD, nitrous oxide increases are not very great and do not offset or cancel out the benefits from SRI and AWD reductions in methane emissions [3,4,7,8].



Measuring GHGs in the rice field

If the changes in methane and nitrous oxide emissions from SRI rice paddies are converted to global warming potential (GWP) as CO_2-equivalent, it has been found that net GHG reductions with intermittent irrigation have ranged between 20% and 40%, and even up to 73% [3,4,7,8].

The production of methane and nitrous oxide from rice paddies is affected by many factors such as soil aeration, redox potential, micro-organisms (respective roles for and competition among different species), soil and air temperature, soil texture, applications of chemical and organic fertilizers, readily-available carbon sources, rates of nitrification and denitrification, root density and root exudates, plant physiology, soil pH, and so on.

These multiple factors cannot be compacted into a simple measure, and there can synergistic effects among some factors that make predictions and measurement difficult. The wide range of variation reported in percentage of methane and nitrous oxide reductions is caused by the complexity of interactions among these factors.

The relationships among the various factors that contribute to carbon dioxide (CO_2) emissions from rice paddies and from rice production overall need to be further studied to get a more comprehensive view of what they contribute to total GHG emissions and global warming. A comprehensive analysis of GHG emissions associated with SRI methods in India, including CO_2, calculated these to be reduced by 40% [3].

Reductions in the use of chemical fertilizer and other agrochemicals as recommended with SRI and AWD will certainly diminish CO_2 emissions since the production and transportation of these manufactured materials definitely adds to carbon dioxide in the atmosphere. Even if the use of agrochemical inputs does not contribute a large portion of GHG emissions, reducing their use while producing more rice is clearly a benefit for farmers and the environment. A study of direct and indirect energy inputs to rice production in Vietnam found that fertilizer made up 64% of the total energy inputs [10]. This indicates that GHG emissions associated with the production and use of fertilizer in such paddy production are non-trivial.

It is clear that making simple changes in water management such as intermittent irrigation, which is an intrinsic component of SRI, can achieve substantial methane reduction benefits [4,7], in addition to producing large increases in yield, reductions in the cost of production, and savings of freshwater, which is becoming an increasingly limiting and valuable resource. Thus, the spread of SRI methods including AWD practices can be a simple and practical method for increasing food supply, reducing water consumption, and mitigating climate change.

SRI and AWD in developing countries can both become methods for meeting the objectives of the Clean Development Mechanism (CDM), introduced by the Kyoto Protocol in 1997 for the mitigation of climate change [9]. By attracting official development aid (ODA) under the terms of Certified Emission Reduction (CER), they could assist countries to comply with GHG reduction targets while increasing rice yield, saving water, and enabling farmers to cope better with climate change [11,12]. This would work to the benefit of both developing and industrialized countries.

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