



Rice Methane Innovation Accelerator

STATE OF SCIENCE

Indicators of Success for Transitioning to Low-emission Rice Systems

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Mitigating methane emissions from rice requires integrated solutions, i.e. a combination of technologies and practices that act synergistically and are optimized based on seasonal CH_4 emission patterns¹. Considering that irrigated rice cropping systems account for the bulk of global methane emissions from rice, they are the primary priority for mitigation action. Key indicators for a successful and sustainable change in irrigated rice systems may include a combination of the following:

PRIMARY ACCELERATOR OBJECTIVES

Low CH_4 emissions per ha. Methane emissions can be expressed per unit of rice area or per unit of rice produced, and vary widely due to differences in soils, climate, and management practices. Average daily emission rates – or Emission Factors (EF) – are commonly used in the IPCC Tier 1 and 2 methodologies to express mean CH_4 emissions per unit area during the growing season. It is critical to consider the total seasonal or annual amount of CH_4 emissions per unit area, which depends on the cropping intensity (1, 2, or 3 rice crops grown per year), the length of each growing season, and how each crop cycle is managed. Of particular importance is the total length of the period under flooding or anaerobic soil conditions.

National average EFs range from less than 1 kg CH_4 per ha per day to more than 3 kg CH_4 per ha per day in Vietnam, with a global average of about 2 kg CH_4 per ha per day².

Hence, average rates of much **less than 1 kg CH_4 per ha per day** summed up over the growing season may provide a general target to aim for (e.g. a rice crop with <100-150 kg CH_4 per ha). More specific annual emission targets should be set for different rice cropping systems to account for differences in cropping intensity.

Low CH_4 emissions intensity per unit of rice produced.

Methane intensity – defined as CH_4 emissions per tonne of rice produced – is another measure for assessing methane-reduction options without compromising food security. On average, the global rice methane intensity has been reported as 51 kg CH_4 per tonne of rice produced, but it varies from less than 40 to about 100 kg CH_4 per tonne or more³. High methane intensities reflect low yields and/or high EFs, and vice versa. In general, countries can achieve low methane intensities through measures that increase rice yields (e.g., cultivars, agronomy), reduce flooded periods, and/or avoid large inputs of fresh organic matter. The interpretation of methane intensity values is complex, but it can be a useful metric for national GHG assessments and targets.

Specific targets may vary, but an average emission intensity of **<30 kg CH_4 per tonne of rice** produced may provide a good initial target, though this depends on the specific system and environment, including the attainable yield potential. CH_4 emissions intensity would be lower in high-yielding environments than in low-yielding environments.

OTHER DESIRABLE OUTCOMES

Solutions for mitigating CH₄ emissions must be designed and implemented in a manner that avoids or minimizes potential negative trade-offs, particularly related to food security, soil and plant health, emissions of CO₂ and N₂O, natural resources management, and farm profitability. Hence, other critical outcomes to consider are:

No significant increase in N₂O emissions compared to the baseline before intervention as N₂O has a Global Warming Potential of 273 and a longer atmospheric lifetime than CH₄ and a long atmospheric lifetime⁴. For example, changing water management to more aerated conditions or shifting from rice to other non-flooded crops may reduce CH₄ emissions, but may also increase N₂O emissions. Ideally, the N₂O increase would be minimal and the net global warming effect of such changes should still be negative.

No significant depletion of soil organic carbon compared to the baseline before intervention. Changing water management to more aerated conditions or shifting from rice to other non-flooded crops may cause a loss of soil organic matter, which should be avoided or minimized through appropriate management practices, such as reduced tillage and application of organic matter.

Maintain crop yield growth at average rates that ensure the necessary global supply of rice. On a global average basis, yield growth rates of >50 kg per ha per year need to be sustained to produce enough rice for a growing world population. Closing the existing yield gaps in many Asian countries would not only produce more rice to meet growing demand⁵, but would also reduce the CH₄ emissions intensity and allow for more crop diversification away from flooded rice.

No greater difficulty in managing soil and plant health constraints compared to the baseline before intervention. This criterion often receives insufficient attention. Significant changes in rice systems management may lead to increased weed problems, micronutrient deficiencies, changes in soil microbes, or a greater incidence of diseases or insect pests⁶.

High recovery efficiency of applied nitrogen fertilizer. Currently, the average recovery efficiency of N applied to rice is around 43%⁷. Increasing it would allow for reductions in fertilizer application rates and environment losses, with direct and indirect benefits for profitability, greenhouse gas budgets, and environmental services.

Reduced total water footprint compared to the baseline before intervention. The total water footprint includes rainfall and irrigation. Although values of 3000-5000 L per kg rice are often cited, it has also been demonstrated that levels of just 1000 L per kg rice can be achieved⁸. Specific targets for that may vary, depending on soil type, irrigation method, environment, and other factors. This criterion is particularly important in regions where water is becoming scarcer or less predictable.

Although it is unlikely that these objectives can all be met in all systems, they provide general guidance on what to aim for. Specific emissions reduction targets need to be tailored to the different rice-based cropping systems and environments because they vary due to differences in climate (growth duration and yield potential), cropping intensity (number of flooded days), and management factors such as variety, organic matter inputs, water or fertilizer management. Critically, successful management changes must increase farmers' economic returns by reducing costs or increasing their income from production, otherwise wider adoption cannot be achieved.



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