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MITIGATION STRATEGIES FOR GREENHOUSE GASES EMISSION IN AGRICULTURE

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ABSTRACT

Agriculture is one of the major sources of greenhouse gas emissions and thus contributes to global climate change. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the three most important greenhouse gases (GHGs), which are emitted mainly through livestock, irrigated rice fields and the application of nitrogenous fertilizers. So, understanding emissions and drivers is essential for the mitigation of GHGs. Agriculture offers potential opportunities for mitigating GHGs emissions largely through reducing N_2O and CH_4 emissions, carbon sequestration, soil and land use management, and biomass production. In addition, appropriate mitigation strategies can encourage farmers to adopt mitigation technologies without compromising yield and income.

INTRODUCTION

Agriculture is now facing challenges of increased food production, adapting to climate change and reducing greenhouse gas emissions. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the three most important greenhouse gases (GHGs) in agriculture. The biological breakdown of soil organic matter under aerobic circumstances and the disruption of soil and vegetation carbon reservoirs by tillage and ploughing are the principal sources of CO_2 emissions from agricultural soils. Submerged rice fields are the potential source of CH_4 produced by the microbial decomposition of organic matter under anaerobic conditions. Inorganic and organic nitrogenous compounds in soil, fertilizers, and manure are major sources of N_2O. With a goal of limiting warming to 1.5 °C, the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) set a target to keep global warming far below 2°C. A significant reduction in emissions from the agricultural sector is needed to achieve this aim.

SOURCES OF GREENHOUSE GASES IN AGRICULTURE

1. Enteric Fermentation: Enteric fermentation, a digestive process by which microorganisms break down carbohydrates into simple molecules for absorption into the bloodstream, produces methane in herbivorous animals as a by-product. Methane is mostly produced by ruminant livestock (such as cattle, buffalo, goats, and sheep) and, to a lesser extent, by non-ruminant animals (e.g., pigs and horses).

2. Manure Management: Manure storage, treatment, and application to pastures all produce CH_4 and N_2O. Methane is produced when manure decomposes anaerobically during storage and treatment. Combining nitrification and denitrification of the nitrogen in the manure results in direct N_2O emissions. Volatile nitrogen losses during solid storage, primarily in the form of ammonia and NOx, cause indirect emissions.

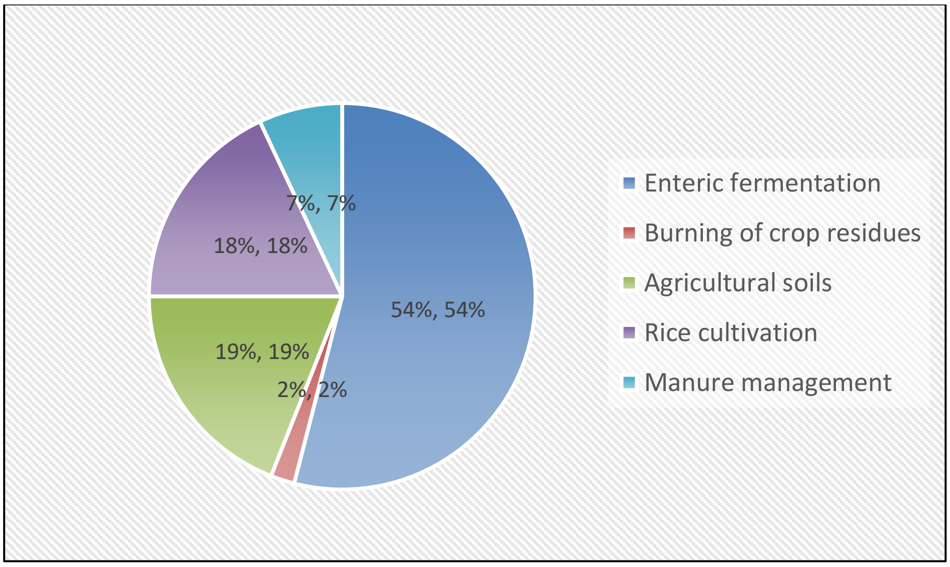

Fig.1. Sources of greenhouse gases emission in agriculture

3. Rice cultivation: The bacterial breakdown of complex organic materials results in the production of CH_4 in the anaerobic environment of the flooded rice ecosystem. Methanogens are the bacteria/archaea engaged in this process, also known as methanogenesis. The majority of methane released into the atmosphere by rice plant aerenchyma tissues. The duration of the crop, the watering schedule, and the addition of organic soil amendments all affect the annual quantity of CH_4 released from a particular area of rice.

4. Agriculture soils: There are two pathways of N_2O emissions from soils - direct and indirect. Direct N_2O emission was estimated using net N additions to soils (synthetic or organic fertilizers, deposited manure, crop residues) and mineralization of N in soil due to cultivation/land-use change on mineral soils. The indirect N_2O emission was estimated from the volatilization of NH_3 and NOx from managed soils and the subsequent re-deposition of these gases and their products (NH_4 and NO_3) to soils and after leaching and runoff of N, mainly as NO_3 from managed soils.

5. Burning of crop residues: Carbon monoxide, CH_4, N_2O, Nitrous oxides, and a variety of other gases are produced when crop residue is burned in the fields. Due to their widespread production throughout the nation, residues from eight crops-rice, wheat, cotton, maize, millet, sugarcane, jute, rapeseed, and mustard are typically burned in the field.

STRATEGIES FOR MITIGATING GREENHOUSE GASES EMISSION

A. Mitigation of methane emission from rice field

- Alternate wetting and drying (AWD)- the practice of flooding a farm field, letting it dry until the top soil layer begins to dry out, and then repeatedly flooding and draining the area throughout the season.
- Direct rice seeding (DSR)
- System of rice intensification (SRI)
- Screening of rice cultivars with few unproductive tillers, high root oxidative activity, and high harvest index.
- Rice straw management through off-season application under dry soil conditions, composting, turning rice straw into biochar and better nutrient management
- Applying fermented manure like biogas slurry in place of unfermented farmyard manure.

B. Mitigation of nitrous oxide emission

- Enhancing N use efficiency with the use of the right kind of fertilizer applied with the right method at the appropriate rate, time, and place
- Demand-driven N use using a leaf colour chart (LCC)
- Use of manure or integrated use of manure and fertilizer to reduce reliance on chemical fertilizer
- Application of N based on soil test and use of technologically advanced fertilizers such as slow-release fertilizers or nitrification inhibitors such as coated calcium carbide and dicyandiamide
- Plant breeding and genetic modifications to increase the N uptake

C. Sequestration of carbon in agricultural soils

Carbon sequestration is the long-term capture and storage of carbon in the soil, water, vegetation and engineering structure that would otherwise be emitted to the atmosphere. Terracing, contour strips, and cover crops can be used to avoid soil erosion and preserve the carbon that is already present in the soil by slowing the pace at which organic matter decomposes. By keeping agricultural wastes on the soil, cultivating perennial plants with larger root systems, using slow-degrading carbon sources like biochar, and integrating and balancing the usage of plant nutrients, the system's carbon content can be increased.

D. Reducing emissions from ruminants and manure management

Feeding should be improved with more efficiency to cut emissions, and manure management procedures should be followed. Feeding efficiency is improved by forages and dietary supplements that suppress methanogenesis. Livestock diets are improved with the addition of supplements and additives to feed. Methane can be produced by the anaerobic fermentation of manure in biogas digesters and utilized as fuel or turned into energy. So, effective manure management and its soil application decrease the need for synthetic fertilizers, replace fossil fuels, provide marketable goods, and boost crop and pasture productivity, lowering GHG's emission intensity.

E. Genetic enhancement of crops and animals

It is necessary to investigate how to find features in a genome that will boost output and reduce emissions. Most research to date has concentrated on decreasing anti-nutritional factors in feed, improving feed palatability, and raising feed conversion ratios (FCRs).

F. Enhancing input-use efficiency and conservation agriculture

The efficiency of agricultural inputs such as water, nutrients, pesticides, and labour is low in agricultural production. This causes more losses and GHG emissions. Increased mechanization in agriculture and increased use of resource-conserving technology, such as those that save water, labour, and nutrients, can minimize waste, enhance revenues, and reduce greenhouse gas emissions. Farmers can reduce GHG emissions and earn money by implementing some of these technologies. Additionally, using agricultural feedstocks instead of fossil fuels to produce electricity can decrease GHG emissions.

CONCLUSION

The agriculture sector shares a major proportion of total GHGs with carbon dioxide, methane and nitrous oxide emissions. Mitigation of GHG emissions from agriculture can be mitigated by sequestering carbon and reducing the emissions of methane and nitrous oxide emissions through changes in land-use management and enhancing input-use efficiency. A win-win solution would be to develop mitigation strategies that help adapt to climate change and promote sustainable agricultural development.

REFERENCES

Ali, M.A., Sattar, M.A., Nazmul-Islam, M., Inubushi, K., (2014). Integrated effects of organic, inorganic and biological amendments on methane emission, soil quality and rice productivity in irrigated paddy ecosystem of Bangladesh: field study of two consecutive rice growing seasons. *Plant and Soil*.**378:** 239–252.

Greenwood DJ. The effect of oxygen concentration on the decomposition of organic materials in soil. *Plant Soil*. 1961; **14**: 360–376.

Haynes, R. J. (2005). Labile organic matter fractions as central components of the quality of agricultural soils: an overview. *Advances in agronomy*. **85:**221-268.

IPCC (2014) Summary for Policymakers, In: Climate Change, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.1- 31

IPCC, 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability Working Group II Contribution to the Fifth Assessment Report. Cambridge University Press, Cambridge, UK and New York, NY USA.

Malyan, S.K., Bhatia, A., Kumar, A., Gupta, D.K., Singh, R., Kumar, S.S., Tomer, R., Kumar, O., Jain, N., (2016). Methane production, oxidation and mitigation: a mechanistic understanding and comprehensive evaluation of influencing factors. *The Science of the Total Environment* .**572:** 874–896.

Mitra, S., Jain, M. C., Kumar, S., Bandyopadhyay, S. K., & Kalra, N., (1999). Effect of rice cultivars on methane emission. *Agriculture, ecosystems & environment*. ***73***(3): 177-183.

Pathak, H., Jain, N., Bhatia, A., Patel, J., & Aggarwal, P. K. (2010). Carbon footprints of Indian food items. *Agriculture, ecosystems & environment*, *139*(1-2), 66-73.

Pathak, H., Kumar, S., Jain, N., Mitra, S., (2008). Emission of methane from soil. In: Pathak, H., Kumar, S. (Eds.), Soil and greenhouse effect, Monitoring and Mitigation, first ed. CBS Publishers & Distributors, New Delhi**, pp**. 18–32.

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