Improving Crop Production by Reducing Methane Emission Using Ai

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***Abstract*— The Agriculture is the largest anthropogenic source of methane (CH4), emitting 145 Tg CH4 y−1 to the atmosphere yearly, makes up to 12% of global methane emissions – and a staggering 1.5% of total greenhouse gas emissions. When rice is harvested, a ton of rice stubble and straw is left behind for every ton of harvested rice –as per 2015 range of 750 million tons globally left behind. In India seasonally methane emission range from 40.8 to 48.5 kg/ha. Most methane is emitted through the rice plant, thus improved rice growth (more tiller and roots) in response to fertilizer application increases emission. But source and mode of application may also have direct effects the climate changes and rice fields. Per year there are 50 to 100 tones of methane are emitted in rice field. Biogas, derived from organic matter decomposition, could curb CH4 emissions from animal and human waste. Demand-side interventions like shifting to a plant-based diet and reducing food loss could cut methane emissions by over 50 Tg CH4 annually by 2050. Despite CH4 being short-lived, urgent action is needed to reduce all greenhouse gases, including CO2 and N2O, to combat global warming. Quickly reducing methane emissions is crucial for meeting 2050 climate targets due to methane's potent radioactive forcing and relatively short lifetime. Despite this urgency, rapidly rising emissions, particularly from agriculture, pose a challenge. Agriculture contributes 40-46% of global methane emissions, with a projected 40% increase by 2050.This includes two-thirds from enteric methane in ruminant livestock, 20% from rice, and 7% from managed manure .We need to control the methane emission otherwise global temperature are increase rapidly. In that case our project are help to reduce the methane emission, and also improve crop(rice) production in the field. we use the gas detection sensor to detect methane in agriculture filed . And its alert our mobile phone or automatically system is activated and done there process. It also check the climate condition and the water level of land simultaneously. And then its maintained the irrigation process for lands.**

Keywords*—Methane emissions, agriculture, rice production, greenhouse gases, biogas, climate change, mitigation strategies, gas detection sensors, irrigation management, global warming.

I. Introduction

Methane (CH4) emission from rice fields represents a significant environmental challenge, contributing notably to global greenhouse gas (GHG) emissions. As the demand for rice continues to grow with the world's population, especially in Asia, the implications of these emissions for climate change become increasingly critical. This essay delves into the mechanisms of methane production in rice paddies, the factors influencing these emissions, and potential mitigation strategies to address this pressing issue.

Methane production in rice fields primarily occurs through anaerobic decomposition of organic matter in the soil. Rice paddies are unique agricultural systems where the fields are flooded for significant periods during the crop cycle, creating anoxic (oxygen-free) conditions ideal for methanogenic arches. These microorganisms metabolize organic carbon present in the soil and plant material, producing methane as a byproduct. This methane then diffuses through the water column, is transported through the rice plants themselves, or is released through ebullition (bubbling) into the atmosphere.

The extent and duration of flooding in rice paddies significantly impact methane emissions. Continuously flooded fields generally produce more methane than those subjected to intermittent drying and rewetting. The practice of alternate wetting and drying (AWD) has been shown to reduce methane emissions substantially.

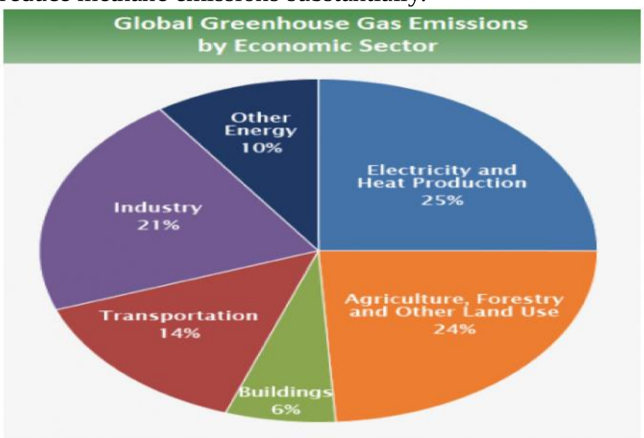


fig 1 : Global Greenhouse gas emissions by economic sector

The composition and condition of the soil play critical roles in methane emissions. Soils rich in organic matter fuel more robust methanogenic activity, leading to higher emissions.

Soil pH and temperature also affect methane production rates, with warmer conditions accelerating the process. The variety of rice grown can influence methane emissions, with some cultivars more efficient at transporting methane from the soil to the atmosphere than others. The type and amount of fertilizer applied to rice fields can affect methane emissions. Organic fertilizers, such as manure, typically increase methane production compared to inorganic fertilizers, although the latter can still stimulate methanogenesis indirectly by enhancing plant growth and thus providing more organic substrate to the methanogens Rice cultivation is a staple food production system for over half the world's population, making it a critical sector for food security. However, it is also among the largest agricultural sources of methane, a potent greenhouse gas with a global warming potential approximately 28 to 34 times greater than CO2 over a 100-year period. The global significance of methane emissions from rice fields is thus twofold: it represents a considerable fraction of agricultural methane emissions and plays a non-negligible role in global climate change dynamics.

II. Background and Related Works

Methane emission from agricultural practices, especially rice cultivation, poses a considerable challenge due to its potent greenhouse gas effect, contributing to global warming. Traditional methods to mitigate these emissions have included water management, crop rotation, and selective breeding. However, the integration of AI technologies presents a novel approach to not only managing these emissions more effectively but also enhancing overall crop production.

Recent advancements in AI have led to the development of precision agriculture, which utilizes data analytics, machine learning (ML), and IoT devices to optimize farming practices. Several key areas where AI contributes to reducing methane emissions while improving crop yields.

AI models can analyze weather data, soil moisture levels, and crop growth stages to optimize irrigation schedules. By predicting the optimal times for watering and employing techniques like alternate wetting and drying (AWD), AI helps reduce the duration of field flooding, thus lowering methane emissions. Machine learning algorithms can assess soil health from data collected through sensors and satellite imagery. By understanding soil conditions in real-time, farmers can adjust their cultivation practices, reducing the need for excessive organic fertilizer application and minimizing conditions conducive to methane production.

AI can aid in selecting the best crop varieties that are less prone to methane emission. By analyzing genetic information alongside environmental and management data, AI systems can recommend cultivars that produce higher yields with lower methane emissions. AI-driven systems can precisely calculate the optimal amount and type of fertilizers needed for specific crop stages, minimizing the use of organic fertilizers that contribute to methane emissions when decomposed anaerobically.

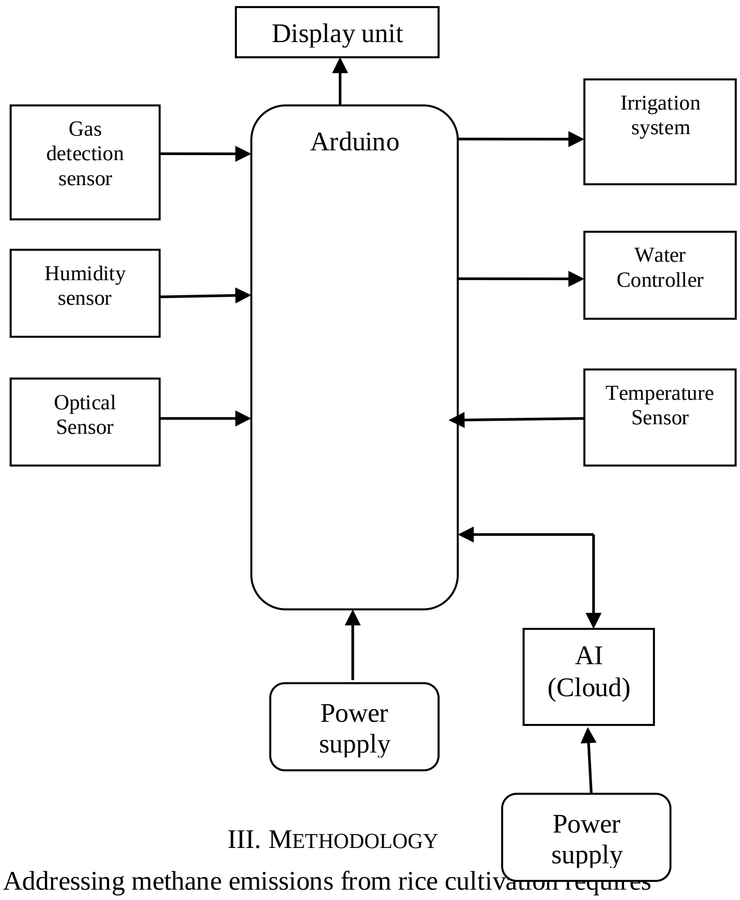
Utilizing drones and satellite imagery, AI algorithms can monitor crop health, soil moisture, and methane emission hotspots in real-time. This capability allows for targeted interventions, reducing the need for blanket approaches that can lead to overuse of resources and higher methane emissions.

The application of AI in agriculture to reduce methane emissions while improving crop production is still in its nascent stages. However, early results are promising, showing potential for significant environmental and economic benefits. Future directions might include integrating more sophisticated AI models with larger datasets to improve prediction accuracy, developing autonomous systems for farm management, and enhancing AI-driven decision support systems for farmers.

Collaboration between AI researchers, agronomists, and environmental scientists is crucial to address the multifaceted challenges of reducing methane emissions from agriculture. By combining domain knowledge with advanced AI techniques, it is possible to devise solutions that are not only effective in mitigating climate change impacts but also in ensuring food security for the growing global population.

AI in agriculture offers a promising pathway to reducing methane emissions while enhancing crop production. Continued research and development in this area, supported by policy and investment, are key to realizing the full potential of AI-driven agricultural practices in the fight against climate change.

III BLOCK DIAGRAM



III. Methodology

Addressing methane emissions from rice cultivation requires a multifaceted approach, combining agronomic, water management, and breeding strategies to reduce the carbon footprint of rice production.

Implementing controlled irrigation techniques such as AWD can significantly reduce methane emissions by exposing the soil to the air intermittently, thus inhibiting methanogenic activity. Research into chemical and biological methane inhibitors offers promising avenues for directly reducing methanogenesis in rice paddies. Developing and adopting rice cultivars that are less prone to emitting methane, either through reduced plant-mediated transport or through lower demand for soil organic matter, can contribute to emission reductions. Modifying the timing and manner of organic matter addition to the fields (e.g., composting rice straw instead of direct incorporation) can reduce the substrate available for methanogenesis. Introducing non-rice crops into the cropping system can help break the continuous cycle of methane production associated with rice cultivation

The system integrates gas sensors for methane detection in agricultural land, enabling real-time monitoring of methane emissions. Upon detection of methane, the system triggers actions to mitigate emissions and optimize agricultural practices.

Firstly, based on the water level in the land, excess water is identified and removed using a motorized system, thereby preventing water logging which can exacerbate methane emissions. Simultaneously, the irrigation system is controlled to deliver the precise amount of water required

IV.CONCLUSION

The Methane emissions from rice fields are a significant concern in the context of global climate change, driven by the anaerobic decomposition of organic matter in flooded soils. While the demand for rice as a staple food continues to grow, it is imperative to balance this need with sustainable practices that minimize environmental impacts. Through a combination of improved water management, cultivar selection, and innovative agricultural practices, it is possible to reduce the methane footprint of rice cultivation. Addressing these emissions is not only critical for climate change mitigation but also for ensuring the sustainability of rice production systems vital for global food security. The challenge lies in implementing these strategies at scale, requiring concerted efforts from governments, researchers, farmers, and the international community.

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