EPRA International Journal of Environmental Economics, Commerce and Educational Management
Journal DOI: 10.36713/epra0414 |ISI I.F Value: 0.815|SJIF Impact Factor (2026): 8.752 ISSN: 2348 – 814X
Volume: 13 | Issue:5 | May 2026 -Peer Reviewed Journal

EMISSION IN INDIAN AGRICULTURE: MITIGATION AND PRACTICES

Tejashwini Talwar[1], Dr. Manoj Dolli[2]
[1]*Research Scholar Department of Economics Karnataka University, Dharwad*
[2]*Professor, Department of Economics, Karnataka University, Dharwad*

Article DOI: https://doi.org/10.36713/epra27711
DOI No: 10.36713/epra27711

ABSTRACT
The main feature of Indian society is that 63% of people live in rural areas, and 58% of the total population relies on agriculture for their livelihood. The growing demand for food and security is putting more pressure on land and climate. Agrarian countries like ours are highly vulnerable to climate conditions such as extreme rainfall, drought, pests, and diseases. Nonetheless, agricultural subsectors, such as livestock, biomass burning, and rice cultivation, emit high levels of greenhouse gases, which are also one of the leading contributors to global climate warming. Carbon dioxide (CO2), methane (CH4), and nitrous oxide (NO2) are the main culprits. heavily emitted from burning stubble, animals, and fertilizers. Agricultural activities alone account for 10–12% of global GHG emissions. After the Green Revolution, India became a food hub for the world, leading to the exploitation of natural resources. To deal with GHG emissions mitigation and adaption, the United Nations Framework Convention on Climate Change (UNFCCC) built the Paris Agreement in November 2015 to limit the world temperature to 1.50–20 °C. The existing literature suggests that policymakers, stakeholders, and communities evaluate current agricultural practices. This study analyses greenhouse gas point sources, which are toxic gases, and reviews current agriculture-related climate policy and best practices to reduce pollutants. Smart farming technologies are suggested.
KEYWORDS: *Greenhouse gas emissions from CO2, CH4, and NO2 sources, review old methods, and climate-related policies. Suggestions for New Techniques.*

SIGNIFICANCE OF STUDY

Agriculture is an important economic sector, along with the security of food and nutrition worldwide. In India, 16% of the emissions are from agriculture. Three major pollutants, carbon dioxide, which is a 60 percent contributor to global warming, NO_2 depletes ozone (Gupta et al., 2021). Methane, which stays in the atmosphere longer than CO_2, especially from live stock (*FAOSTAT*, n.d.), this study explores cost-effective methods that reduce greenhouse gases such as zero tillage, effective fertilizer use, and water management. Government action and encourages investment in innovation. The world is facing unusual consequences owing to global warming. India is not different. Recently, we witnessed floods in the north, landslides at Kerala, and so on. This study highlights the importance of sustainable agriculture transition, protection of the environment, and the welfare of farmers amidst climate tension.

REVIEW OF LITERATURE

Literature was studied, including previously published works, such as books, articles, or theses on a fixed research area.

Jain, 2012: Global warming is driven largely by greenhouse gases, and agriculture plays a significant role, mainly through methane and nitrous oxide emissions. Within agriculture, enteric fermentation and rice cultivation are the big culprits. One promising finding is that direct-seeded rice (DSR) can cut methane emissions, save water, and reduce labour and energy use compared with the traditional transplanted rice. Economic evaluations suggest many mitigation options are either cost-effective or can boost farmer income, and there are even potential gains from carbon trading in certain contexts. To realize these benefits, policy measures are needed: incentives for water savings, subsidies to support adoption, training and outreach, better weather forecasting, and the development of affordable, simple technologies that farmers can reliably use.

Vetter et al., 2017: Globally, agriculture drives a large share of greenhouse gas emissions, and as the world's population grows, we're under pressure to feeding people. GHG s from India's main food crops and livestock products, comparing farm-management emissions across cereals, pulses, potatoes, fruits and vegetables, and animal products. It finds that livestock and rice are the biggest culprits in India, with averages of about 5.65 kg

EPRA International Journal of Environmental Economics, Commerce and Educational Management
Journal DOI: 10.36713/epra0414 |ISI I.F Value: 0.815|SJIF Impact Factor (2026): 8.752 ISSN: 2348 – 814X
Volume: 13 | Issue:5 | May 2026 -Peer Reviewed Journal

CO2eq per kg of rice, while cereals (other than rice) and fruits/veg emit far less. mitigation of emission can require policies and practices that encourage efficient farming, reduced waste, and smarter consumption patterns.

Bhatia et al., 2013a: Emission of CH_4 from Indian rice fields has remained almost constant.N_2O emissions from agricultural soils due to increased inorganic fertilizer application.

Bhatia et al., 2004 greenhouse gas emissions from agricultural soils in India, focusing on methane (CH4) and nitrous oxide (N2O). It notes that soil diversity, land use, and climate introduce uncertainties in quantifying these emissions.

Hemingway et al., 2023: carbon footprint of an Indian village influenced by the Green and White Revolutions, focusing on both crops and livestock. Using life cycle and comparative agricultural analysis, it evaluates emissions from multiple farming systems. The main emission sources are mineral fertilizers, irrigation, and methane from paddy fields. Livestock contributes significantly, mainly through enteric fermentation, with emissions ranging widely across farms. At the village level, livestock accounts for about 60% of total GHG emissions. The findings reveal that intensive livestock farming, though historically driven by productivity goals, now poses major environmental and socio-economic challenges.

Khatri-Chhetri et al., 2023: Agricultural policies often emphasize new technologies to boost productivity, overlooking the potential of improving technical efficiency. Enhancing efficiency can significantly reduce greenhouse gas emissions while conserving scarce resources like land and water. Better use of existing technologies lowers input needs and production costs. This approach offers both economic and environmental benefits, making it vital for sustainable agricultural growth.

RESEARCH METHODOLOGY

study goes by gathering relevant data on livestock, crop burning, rice cultivation, crop area, from recent government websites and research reports. Data will be based on activity region wise and year wise using simple excel. Calculating emission. Review literature about mitigation practices in agriculture. Suggest practical solution like reduce emission

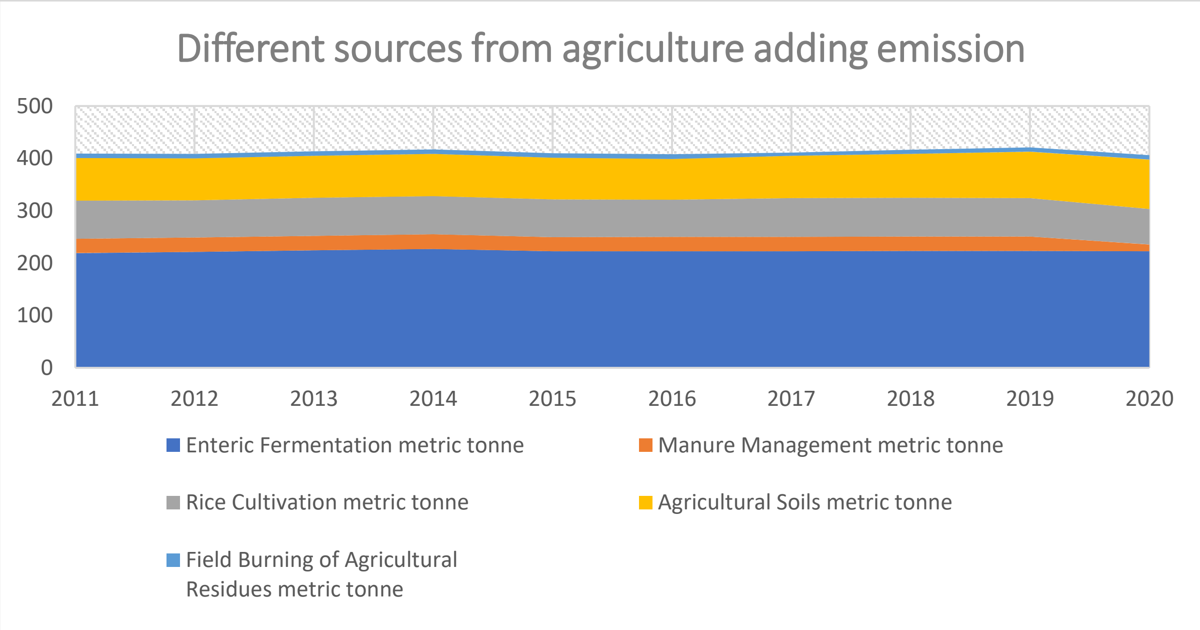
OBJECTIVES OF STUDIES:

Quantify emission sector wise
Assess common farming practice
Identify policy gaps and suggest practical suggestion.

Quantify emission sector wise: As India majorly Agricultural country and one of contributor to economy, provide food security. along with that it is become important reason for climate change. Especially they are five points of sources emit huge CO_2, CH_4 and N_2O first one is enteric fermentation (livestock) Enteric fermentation is a natural digestive process that occurs in the stomachs of ruminant animals like cattle, sheep, goats, and buffalo. By product its produce huge methane (CH_4) which stays in atmosphere longer than carbon. According to Department of Animal Husbandry and Dairying (DAHD, 2025), India's total livestock population stands at around 535.78 million animals (*LIVESTOCK CENSUS*, n.d.) second source of N_2O is using fertilizers. Ever since green revulsion (1960's) use of chemical fertilizers has increased dramatically—by nearly 800% from 1960 to 2000 (*Green Revolution Impact*, 2025). And Rice cultivation area has been increased since 1960 's 31.7% to 159%(*FAOSTAT*, n.d.) west Bengal, Uttar Pradesh and Panjab along with Odisha, Andhra Pradesh, Bihar, Chhattisgarh, Tamil Nadu, Assam, Telangana significant contributor to paddy cultivation Manure management India produces a large amount of livestock manure annually, as it has the world's largest livestock population. Estimates suggest that India generates approximately 520 million tonnes (MT) of organic manure each year from livestock waste and other agricultural residues (Chadwick et al., 2011) another major sources of emission is crop burning Crop burning from fields like wheat and rice stubble emits Source Crop burning from fields like wheat and rice stubble emits approximately 177,046.73 Gg/year of CO_2, 10,751 Gg/year of CO, 315.51 Gg/year of CH_4 (methane), and 8.18 Gg/year of N_2O (nitrous oxide)(Aher et al., 2025)

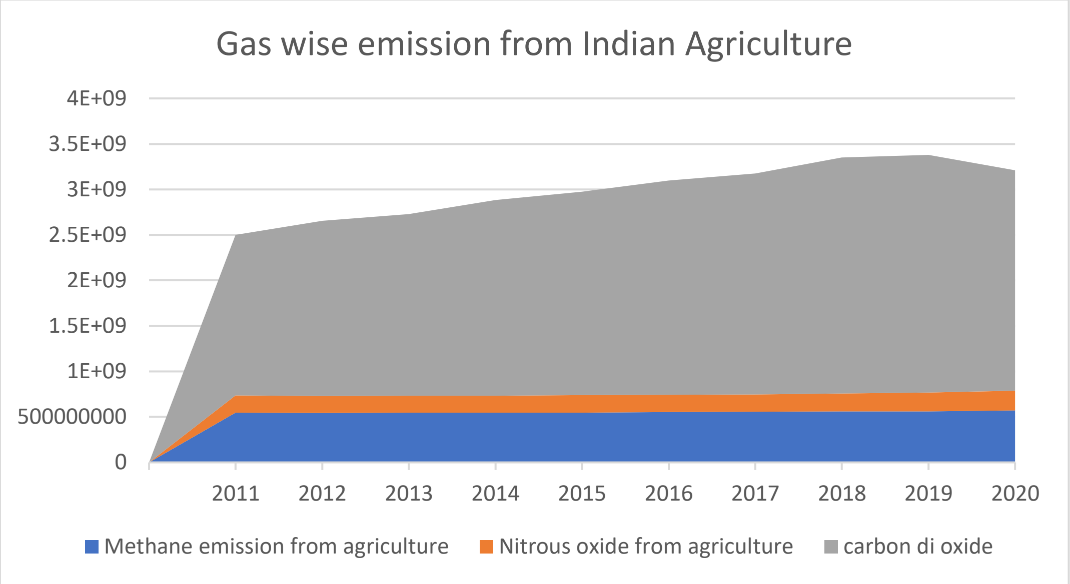
EPRA International Journal of Environmental Economics, Commerce and Educational Management
Journal DOI: 10.36713/epra0414 |ISI I.F Value: 0.815|SJIF Impact Factor (2026): 8.752 ISSN: 2348 – 814X
Volume: 13 | Issue:5 | May 2026 -Peer Reviewed Journal

Source	Share in Agricultural Emissions	Key Gases	Description
Enteric fermentation (livestock digestion)	50–55%	Methane (CH_4)	Methane is released from the digestive processes of cattle—India has the world's largest cattle population, making this the top source of CH_4 emissions.
Fertilizer and soil emissions	20–25%	Nitrous oxide (N_2O)	Overuse of urea fertilizers and poor nitrogen management in soils release significant N_2O, mainly from agricultural soils and nitrification–denitrification processes.
Rice cultivation	15–18%	Methane (CH_4) and N_2O	Flooded paddy fields foster anaerobic conditions, producing large methane emissions—around 3.4 teragrams annually, equivalent to 71 Mt CO_2e.
Manure management	4–6%	CH_4 and N_2O	Poor handling and storage of livestock manure, especially in liquid form, lead to anaerobic decomposition and gas release.
Crop residue burning	2–4%	CO_2, CH_4, N_2O	Predominantly in rice–wheat systems of Punjab, Haryana, and Uttar Pradesh, causing seasonal spikes in regional emissions.



Sources: Down to Earth data source
This chart shows greenhouse gas emissions from agriculture between 2011 and 2020.
Enteric fermentation remains the largest contributor, followed by emissions from agricultural soils and rice cultivation. Manure management and crop residue burning contribute relatively small portions. Overall, emissions stayed nearly stable with slight fluctuations, suggesting limited progress in reducing agricultural emissions.

Assess common farming practice: some of traditional practice adding more pollution **like** Flooded Paddy Cultivation, Livestock and Manure Management, Excessive Nitrogen Fertilizer Use Crop Residue Burning, Soil Disturbance and Tillage.



Source: our world data sources

This graph shows the trend of greenhouse gas emissions from Indian agriculture between 2011 and 2020.Carbon dioxide is by far the largest emitted gas, with methane and nitrous oxide contributing smaller but important amounts. Carbon dioxide is by far the largest emitted gas, with methane and nitrous oxide contributing smaller but important amounts. Emissions have steadily increased, peaking around 2019 before a slight dip in 2020, reflecting changes in agricultural activity or practices. These gases come from typical farming actions like soil management, fertilizer use, and livestock digestion, which impact climate change**.**

Methane: Methane is a colourless, odourless gas (CH_4) and a powerful greenhouse gas, much stronger than carbon dioxide at trapping heat in the atmosphere. Major sources of methane emissions include **livestock digestion** (especially cattle), **rice paddies**, India is one of the world's largest methane emitters, with agriculture (mainly enteric fermentation and rice cultivation) responsible for around 70% of its methane emissions Methane has a global warming potential over 28 times greater than carbon dioxide in a 100-year period.(Bhatia et al., 2013b)

Nitrous oxide:(N_2O), also called "laughing gas," is a colourless, non-flammable gas used in medicine but is also a potent greenhouse gas with a global warming potential nearly 300 times higher than carbon dioxide. The main sources of N_2O emissions are agricultural activities—especially the use of **nitrogen-based fertilizers, manure management**, and biological processes in soils. In India, agriculture is the dominant source, with the country emitting about 600,000 tonnes of nitrous oxide per year, mostly from fertilizer use and soil management. (Bhatia et al., 2013a) N_2O not only accelerates climate warming but also depletes the ozone layer, posing a double threat to both climate and atmospheric health.

Carbon dioxide:(CO2) is a colourless gas naturally present in the atmosphere and a major greenhouse gas driving climate change by trapping heat in agriculture, CO2 emissions come from several sources in India**, including the use of fossil fuel-powered machinery**, production and **application of fertilizers**, **soil disturbance**, **crop residue burning**, and **deforestation.** (Ghosh, 2018) CO2 increases global warming by enhancing the greenhouse effect. Though less potent per molecule than methane and nitrous oxide, its much larger volume makes it a significant climate threat, exacerbating temperature rise and extreme weather.

Identify policy gaps and suggest practical suggestion: large agriculture dependency country like us should adopt best management practice should be adopt

Identifying policy gaps

- ✓ **Limited inclusion of agriculture in national climate frameworks**: Energy sector, industrial sector are part of national action plan for climate change. But agriculture not integrated in it.
- ✓ **Lack of Methane and Nitrous oxide emit limit**: India not signed pull pledge of global methane and also not set limit nitrous oxide as part of National Determined Commitments.
- ✓ **Insufficient farmer-level incentive mechanisms:** climate smart adoption incentives not available for formers. If farmer practice lower green house gases emission under subsidy they get more stimulate for new innovation.
- ✓ **Weak monitoring, reporting, and verification**: whatever data available about agriculture is on bases of IPCC regulation reginal level its not found that's should adopted.

Suggestions and conclusion:

- ✓ Alternate Wetting and Drying (AWD) is a simple water-saving method used in rice farming. Instead of keeping the paddy flooded all the time, farmers let the water drain for a few days before reflooding it. This gives oxygen to the soil, reducing methane gas released from standing water. It saves water, cuts pollution, and keeps rice yields the same. (Gupta et al., 2021)
- ✓ The **System of Rice Intensification (SRI)** is a simple, eco-friendly way to grow rice using less water and fertilizer. Farmers plant **young single seedlings** with more space between them so each plant grows stronger roots. The field is kept moist, not flooded, which saves water and cuts emission.
- ✓ Feed optimization in livestock means giving animals the right mix of nutrients so they stay healthy and grow efficiently while reducing waste. Farmers adjust feed based on each animal's age, weight, and health to avoid overfeeding or nutrient loss. Using quality ingredients, supplements, and balanced diets helps animals digest food better. This not only boosts productivity but also lowers methane emissions and feed costs (*Effective Strategies to Reduce Methane Emissions from Livestock*, n.d.)
- ✓ Biogas capture from manure works by collecting animal waste and letting it decompose in a sealed tank called an **anaerobic digester**. Inside, bacteria break down the manure without oxygen, releasing a gas made mostly of methane and carbon dioxide. The biogas is then captured and used as clean energy for cooking, heating, or electricity. This process reduces methane emissions, saves energy costs, and turns farm waste into something useful.(*Biogas in Organic Agriculture—Effects on Productivity, Energy Self-Sufficiency and Greenhouse Gas Emissions | Renewable Agriculture and Food Systems | Cambridge Core*, n.d.)
- ✓ Nitrification inhibitors and biofertilizers help farmers use fertilizers more efficiently while cutting pollution. Nitrification inhibitors slow down how soil bacteria turn nitrogen into nitrate, reducing nitrous oxide emissions and nutrient loss. Biofertilizers add helpful microbes that naturally boost soil nitrogen and crop growth. Together, they reduce chemical fertilizer needs, protect soil health, and keep the environment cleaner.(*Nitrous Oxide (N2O)-Reducing Denitrifier-Inoculated Organic Fertilizer Mitigates N2O Emissions from Agricultural Soils | Biology and Fertility of Soils*, n.d.)
- ✓ Legume integration means growing crops like beans, lentils, or peas between other main crops as part of rotation or intercropping. These plants work with soil bacteria to naturally fix nitrogen from the air, enriching the soil for the next crop. It cuts down the need for chemical fertilizers while improving soil structure and fertility. Farmers get better yields, healthier soil, and lower costs in a sustainable way (Schmeer et al., 2014)
- ✓ Zero or conservation tillage means planting crops without ploughing or turning the soil. Instead, seeds are placed directly into the soil while leaving crop residues on top. This keeps the soil's structure intact, reduces carbon loss, and helps hold moisture. It saves fuel and time while improving soil health and cutting greenhouse gas emission (Maraseni & Cockfield, 2011)
- ✓ Agroforestry and Tree-Based Farming, Biochar Application, combining India's National Mission for Sustainable Agriculture (NMSA) and Paramparagat Krishi Vikas Yojana (PKVY) Linking climate-smart agriculture (CSA) to carbon credits and payments for ecosystem services.

  Conclusion: Sustainable and climate-smart farming practices create a balance between productivity and planet health. They help farmers grow more food while using less water, energy, and chemicals, keeping soils rich and fertile. These methods, like zero tillage and legume integration, cut harmful emissions and protect biodiversity. Over time, they lower costs, improve food quality, and strengthen rural livelihoods. Together, such practices lead toward a resilient farming future where people and nature thrive together

REFERENCE

1. *Aher, S. B., Raj, D., & Nandi, S. (2025). Air pollution spikes and health risks resulting from wheat crop residue burning in central India. Journal of Health Science Research. https://doi.org/10.25259/JHSR_11_2025*
2. *Anand, S., Dahiya, R. P., Talyan, V., & Vrat, P. (2005). Investigations of methane emissions from rice cultivation in Indian context. Environment International, 31(4), 469–482. https://doi.org/10.1016/j.envint.2004.10.016*
3. *Bhatia, A., Jain, N., & Pathak, H. (2013a). Methane and nitrous oxide emissions from Indian rice paddies, agricultural soils and crop residue burning. Greenhouse Gases: Science and Technology, 3(3), 196–211. https://doi.org/10.1002/ghg.1339*
4. *Bhatia, A., Jain, N., & Pathak, H. (2013b). Methane and nitrous oxide emissions from Indian rice paddies, agricultural soils and crop residue burning. Greenhouse Gases: Science and Technology, 3(3), 196–211. https://doi.org/10.1002/ghg.1339*
5. *Bhatia, A., Pathak, H., & Aggarwal, P. K. (2004). Inventory of methane and nitrous oxide emissions from agricultural soils of India and their global warming potential. Current Science, 87(3), 317–324. https://www.jstor.org/stable/24108935*
6. *Biogas in organic agriculture—Effects on productivity, energy self-sufficiency and greenhouse gas emissions | Renewable Agriculture and Food Systems | Cambridge Core. (n.d.). Retrieved October 25, 2025, from https://www.cambridge.org/core/journals/renewable-agriculture-and-food-systems/article/abs/biogas-in-organic-*

agricultureeffects-on-productivity-energy-selfsufficiency-and-greenhouse-gas-emissions/8CF86303BC33936148FB8679EBE32B36

7. *Chadwick, D., Sommer, S., Thorman, R., Fangueiro, D., Cardenas, L., Amon, B., & Misselbrook, T. (2011). Manure management: Implications for greenhouse gas emissions. Animal Feed Science and Technology, 166–167, 514–531. https://doi.org/10.1016/j.anifeedsci.2011.04.036*
8. *Effective Strategies to Reduce Methane Emissions from Livestock. (n.d.). Retrieved October 25, 2025, from https://doi.org/10.13031/2013.4348*
9. *FAOSTAT. (n.d.). Retrieved September 30, 2025, from https://www.fao.org/faostat/en/#home*
10. *Ghosh, S. (2018). Carbon Dioxide Emissions, Energy Consumption in Agriculture: A Causality Analysis for India. Arthaniti: Journal of Economic Theory and Practice, 17(2), 183–207. https://doi.org/10.1177/0976747918792640*
11. *Green Revolution Impact: Grain Production In India. (2025, May 27). https://farmonaut.com/asia/what-is-green-revolution-7-shocking-impacts-on-india*
12. *Gupta, K., Kumar, R., Baruah, K. K., Hazarika, S., Karmakar, S., & Bordoloi, N. (2021). Greenhouse gas emission from rice fields: A review from Indian context. Environmental Science and Pollution Research, 28(24), 30551–30572. https://doi.org/10.1007/s11356-021-13935-1*
13. *Hemingway, C., Vigne, M., & Aubron, C. (2023). Agricultural greenhouse gas emissions of an Indian village - Who's to blame: Crops or livestock? Science of The Total Environment, 856, 159145. https://doi.org/10.1016/j.scitotenv.2022.159145*
14. *Jain, N. (2012). Low Carbon Technologies for Agriculture: A Study on Rice and Wheat Systems in the Indo-Gangetic Plains.*
15. *Khatri-Chhetri, A., Sapkota, T. B., Maharjan, S., Cheerakkollil Konath, N., & Shirsath, P. (2023). Agricultural emissions reduction potential by improving technical efficiency in crop production. Agricultural Systems, 207, 103620. https://doi.org/10.1016/j.agsy.2023.103620*
16. *LIVESTOCK CENSUS. (n.d.). Retrieved October 24, 2025, from https://www.pib.gov.in/www.pib.gov.in/Pressreleaseshare.aspx?PRID=2114720*
17. *Maraseni, T. N., & Cockfield, G. (2011). Does the adoption of zero tillage reduce greenhouse gas emissions? An assessment for the grains industry in Australia. Agricultural Systems, 104(6), 451–458. https://doi.org/10.1016/j.agsy.2011.03.002*
18. *Nitrous oxide (N2O)-reducing denitrifier-inoculated organic fertilizer mitigates N2O emissions from agricultural soils | Biology and Fertility of Soils. (n.d.). Retrieved October 25, 2025, from https://link.springer.com/article/10.1007/s00374-017-1231-z*
19. *Schmeer, M., Loges, R., Dittert, K., Senbayram, M., Horn, R., & Taube, F. (2014). Legume-based forage production systems reduce nitrous oxide emissions. Soil and Tillage Research, 143, 17–25. https://doi.org/10.1016/j.still.2014.05.001*
20. *Vetter, S. H., Sapkota, T. B., Hillier, J., Stirling, C. M., Macdiarmid, J. I., Aleksandrowicz, L., Green, R., Joy, E. J. M., Dangour, A. D., & Smith, P. (2017). Greenhouse gas emissions from agricultural food production to supply Indian diets: Implications for climate change mitigation. Agriculture, Ecosystems & Environment, 237, 234–241. https://doi.org/10.1016/j.agee.2016.12.024*