

## Rooted in Sustainability: Farming Practices That Lower Greenhouse Gases

R. Shiva Shankar<sup>1\*</sup>, K. Pravallika<sup>2</sup>, A. Latharani<sup>3</sup> and P. Prashanth<sup>4</sup>

<sup>2</sup> Ph.D. Research Scholar, Department of Extension Education, <sup>1\*</sup> Ph.D. Research Scholar, Genetics and Plant Breeding,

<sup>3</sup> Ph.D. Scholar, Department of Extension Education College of Agriculture, Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad- 500030. Assistant Professor, Agricultural College, Palem.

Corresponding Author: sruthikatta97@gmail.com

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### Abstract

Sustainable agriculture plays a vital role in mitigating climate change by reducing greenhouse gas (GHG) emissions while ensuring food security and environmental health. Conventional farming contributes significantly to climate change through deforestation, excessive fertilizer use, and methane emissions from livestock. This paper explores sustainable agricultural practices, including carbon sequestration through conservation tillage, cover cropping, and agroforestry. It highlights strategies to reduce nitrous oxide emissions, such as precision agriculture and organic fertilization, and examines methane reduction techniques like dietary modifications and improved manure management. Additionally, energy-efficient practices and renewable energy integration are discussed as solutions to lower carbon emissions. Despite challenges like high initial costs, knowledge gaps, and policy constraints, sustainable agriculture remains a crucial pathway to reducing the carbon footprint of food production. With strategic investments, education, and supportive policies, these methods can drive climate-friendly farming, contributing to global climate action and food system resilience.

### Introduction

Sustainable agriculture is a crucial strategy in combating climate change by reducing greenhouse gas (GHG) emissions while ensuring food security and ecosystem health. Conventional farming contributes significantly to climate change through deforestation, excessive fertilizer use, and methane emissions from livestock. Sustainable practices mitigate these effects through carbon sequestration, optimized nitrogen use, livestock management, and energy efficiency.

### Carbon Sequestration and Soil Health

Soil is a major carbon sink, and sustainable practices like conservation tillage, cover cropping, and agroforestry enhance carbon sequestration, reducing net CO<sub>2</sub> emissions.

- **Conservation Tillage:** Preserves soil organic matter and reduces CO<sub>2</sub> emissions (Lal, 2004).
- **Cover Cropping:** Improves soil fertility and carbon storage (Gattinger et al., 2012).
- **Agroforestry:** Enhances carbon storage and biodiversity (Nair et al., 2010).

According to the IAEA (2023), these practices improve soil productivity while lowering net CO<sub>2</sub> emissions.

### Reducing Nitrous Oxide Emissions

Nitrous oxide (N<sub>2</sub>O) is a highly potent GHG, largely emitted from synthetic fertilizer use. Sustainable methods to curb N<sub>2</sub>O emissions include:

- **Precision Agriculture:** Optimizes fertilizer use (Zhang et al., 2015).
- **Nitrification Inhibitors:** Reduce ammonium conversion into N<sub>2</sub>O (Akiyama et al., 2010).
- **Organic Fertilization:** Compost and manure reduce N<sub>2</sub>O emissions (Drinkwater & Snapp, 2007).

Studies show that no-tillage farming with slow-release fertilizers can cut N<sub>2</sub>O emissions by 75% (Parton et al., 2021).

### Livestock Management and Methane Reduction

Livestock is a major source of methane (CH<sub>4</sub>), which has a higher warming potential than CO<sub>2</sub>. Sustainable strategies include:

- Dietary Modifications: Seaweed-based feed reduces CH<sub>4</sub> by up to 80% (Machado et al., 2016).
- Manure Management: Anaerobic digesters convert methane into renewable energy (Gerber et al., 2013).
- Rotational Grazing: Improves pasture quality and increases carbon sequestration (Teague et al., 2016).

### Energy Efficiency and Renewable Resources

Sustainable farming enhances energy efficiency and integrates renewable energy sources to cut CO<sub>2</sub> emissions.

- Solar and Wind Energy: Reduces reliance on fossil fuels (Burney et al., 2010).
- Energy-Efficient Machinery: Lowers emissions (Smith et al., 2018).
- No-Tillage Farming: Reduces fuel consumption (Hobbs et al., 2008).

Reports confirm these methods significantly lower emissions while boosting farm productivity (Parton et al., 2021).

### Challenges and Policy Implications

Adoption of sustainable agriculture faces hurdles:

- High Initial Costs: Investments in new technologies are required.
- Farmer Education: Many farmers need training in sustainable practices.
- Policy Support: Government incentives can accelerate adoption.

Global initiatives support sustainable agriculture, with industry leaders advocating for subsidies and incentives.

### Conclusion

Sustainable agriculture is a key solution to reducing GHG emissions through improved soil management, optimized fertilizer use, better livestock practices, and renewable energy adoption. While challenges remain, strategic investments, education, and policy support can facilitate the transition to climate-friendly farming, ensuring food security and environmental sustainability.

### References

Akiyama, H., Yan, X., & Yagi, K. (2010). Evaluation of effectiveness of enhanced-efficiency fertilizers as mitigation options for N<sub>2</sub>O emissions from agricultural soils: meta-analysis. *Agriculture, Ecosystems & Environment*, 136(3-4), 255-265. <https://doi.org/10.1016/j.agee.2010.04.003>

Burney, J. A., Davis, S. J., & Lobell, D. B. (2010). Greenhouse gas mitigation by agricultural intensification. *Proceedings of the National Academy of Sciences*, 107(26), 12052-12057. <https://doi.org/10.1073/pnas.0908755107>

- Drinkwater, L. E., & Snapp, S. S. (2007). *Nutrients in agroecosystems: Rethinking the management paradigm. Agriculture, Ecosystems & Environment*, 116(1-2), 2-3. <https://doi.org/10.1016/j.agee.2006.12.019>
- Gattinger, A., Muller, A., Haeni, M., Skinner, C., Fliessbach, A., Buchmann, N., ... & Niggli, U. (2012). *Enhanced top soil carbon stocks under organic farming. Environmental Research Letters*, 7(2), 024040. <https://doi.org/10.1088/1748-9326/7/2/024040>
- Gerber, P. J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., ... & Tempio, G. (2013). *Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities. Philosophical Transactions of the Royal Society B: Biological Sciences*, 368(1619), 20120386. <https://doi.org/10.1098/rstb.2012.0386>
- Hobbs, P. R., Sayre, K., & Gupta, R. (2008). *The role of conservation agriculture in sustainable agriculture. Agriculture, Ecosystems & Environment*, 124(1-2), 3-12. <https://doi.org/10.1016/j.agee.2007.09.007>
- IAEA. (2023). *Reducing greenhouse gas emissions in agriculture with the help of nuclear techniques. International Atomic Energy Agency. Retrieved from https://www.iaea.org/newscenter/news/reducing-greenhouse-gas-emissions-in-agriculture-with-the-help-of-nuclear-techniques*
- Lal, R. (2004). *Soil carbon sequestration impacts on global climate change and food security. Science*, 304(5677), 1623-1627. <https://doi.org/10.1016/j.agee.2003.08.009>
- Machado, L., Magnusson, M., Paul, N. A., de Nys, R., & Tomkins, N. W. (2016). *Effects of marine and freshwater macroalgae on in vitro total gas and methane production. Animal Feed Science and Technology*, 220, 79-85. <https://doi.org/10.1016/j.anifeedsci.2015.07.002>
- Nair, P. K. R., Kumar, B. M., & Nair, V. D. (2010). *Agroforestry as a strategy for carbon sequestration. Journal of Plant Nutrition and Soil Science*, 172(1), 10-23. <https://doi.org/10.1016/j.agee.2010.07.001>
- Parton, W. J., Hartman, M. D., Del Grosso, S. J., & Martin, R. E. (2021). *Long-term effects of cropping system management on soil carbon dynamics and nitrous oxide emissions. Issues in Science and Technology. Retrieved from https://issues.org/p\_parton/*
- Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P. & Smith, J. (2018). *Greenhouse gas mitigation in agriculture. Agricultural Systems*, 84(1), 1-40. <https://doi.org/10.1016/j.agsy.2018.04.005>
- Teague, W. R., Barnes, M. K., Duke, S. E., Waggoner, J. W., & Dowhower, S. L. (2016). *Grazing management impacts on vegetation, soil biota, and soil chemical, physical, and hydrological properties in tallgrass prairie. Agriculture, Ecosystems & Environment*, 234, 111-125. <https://doi.org/10.1016/j.agee.2016.04.014>
- The Australian. (2025). *Give farmers incentives to lower energy emissions: Industry leaders. The Australian. Retrieved from https://www.theaustralian.com.au/business/agribusiness/give-farmers-incentives-to-lower-energy-emissions-industry-leaders/news-story/5c0d26d4b07af4b5dc2abe100332227e*
- The Guardian. (2025). *Feed the world, but can we do it without wrecking the planet further? The Guardian. Retrieved from https://www.theguardian.com/research-to-reality/2025/jan/24/feed-the-world-but-can-we-do-it-without-wrecking-the-planet-further*
- Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2015). *Managing nitrogen for sustainable development. Field Crops Research*, 184, 153-163. <https://doi.org/10.1016/j.fcr.2014.10.014>