Carbon Chain - Carbon Credit and the Mitigation of Paddy Methane Emissions

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Global Warming and Paddy Methane Emissions

Global Temperature Rise

Over the past 100 years, the average global temperature has increased by ~1°C, with methane contributing 30% to this warming effect.

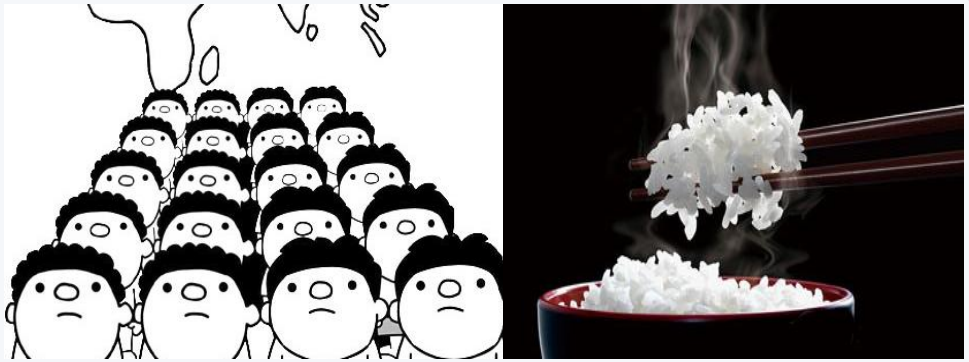
Anthropogenic Sources (Human-Caused)

- Coal Mining & Oil/Gas Extraction--12%
- Municipal Solid Waste Landfills—6%
- **Rice Cultivation (Paddy Fields)—12%**
- Enteric Fermentation (Livestock)—16%
- Animal Waste Management—5%
- Sewage Treatment & Industrial Processes—5%

Natural Sources

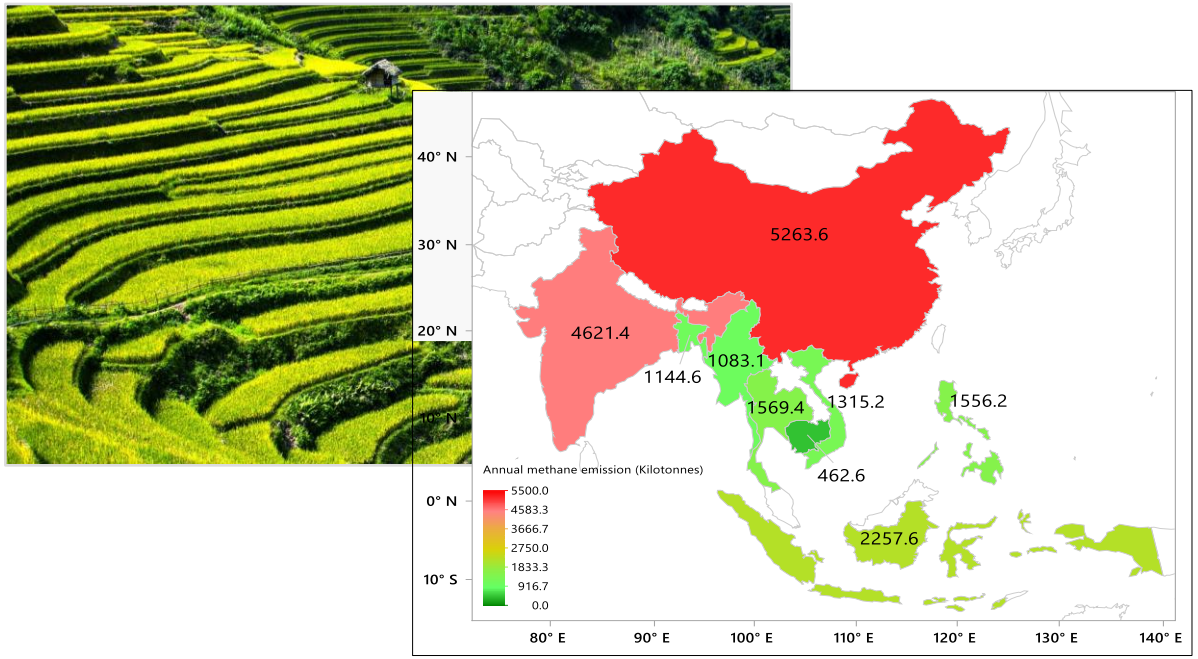
- Wetlands (Largest Natural Source) —22%
- Termites (Microbial Methanogenesis) —4%
- Ocean Water & Marine Sediments —3%
- Natural Biomass Burning—8%

Rice Cultivation and Methane emissions



Rice Cultivation

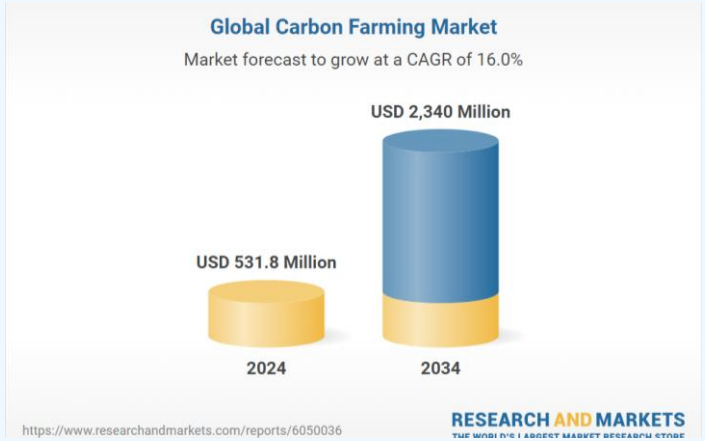
- More than half of the world‘s population relies on rice as their staple food。
- The cultivation area of rice in the world is ca. 167 million ha



For every 100 kilograms of rice produced, 5-10 kilograms of methane are released into the atmosphere.

Rice paddies emit ca. 100 Tg methane into the atmosphere, which equals the global warming caused by the CO2 released by 525 million cars.

Agri-Carbon Market and Paddy Carbon Sinks



Market Growth Projection

The global agri-carbon market is expected to reach $8 billion by 2030, driven by sustainable farming incentives.

Project Implementation

Green Carbon's "1.5 Million Hectares Rice Paddy Project" in Thailand demonstrates large-scale carbon credit generation from rice fields.

Corporate Engagement

Major corporations like Bayer and Shell are partnering to reduce methane emissions in rice cultivation by 30%, linking business with environmental goals.

Strategies for Methane Mitigation in Paddy Fields

Microbial Additives

Introducing or enhancing microbes that consume methane or inhibit its production in the soil.

Field Management

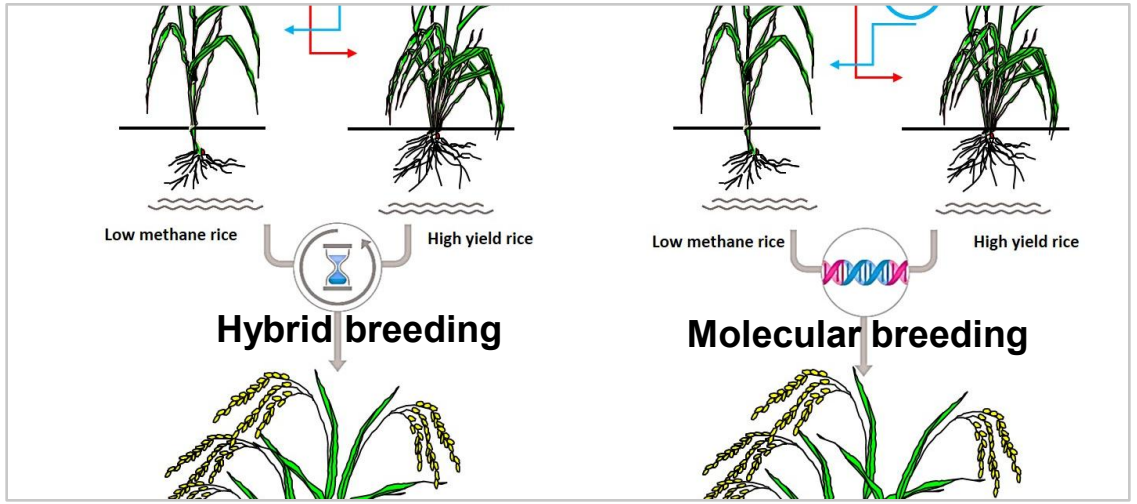
Practices like alternate wetting and drying (AWD), organic matter management, and fertilizer optimization.

Chemical Additives

Using specific chemical inhibitors to suppress the activity of methanogens.

Biological Breeding (Sustainable Approach)

Developing low-methane rice varieties through Hybrid Breeding or Molecular/Genetic Modification.



Carbon optimizing and Paddy Methane Mitigation: Research Background

2012 - 2024 | Swedish University of Agricultural Sciences

Focus: Mechanism of paddy methane emission and mitigation technology research; Breeding of low-methane rice varieties.

2024.09 - Present | Hunan Agricultural University

Focus: Further advancement of mitigation technologies; Breeding novel rice varieties Adapting to local paddy conditions in China.

A Breakthrough: SUSIBA2 Low-Methane Rice

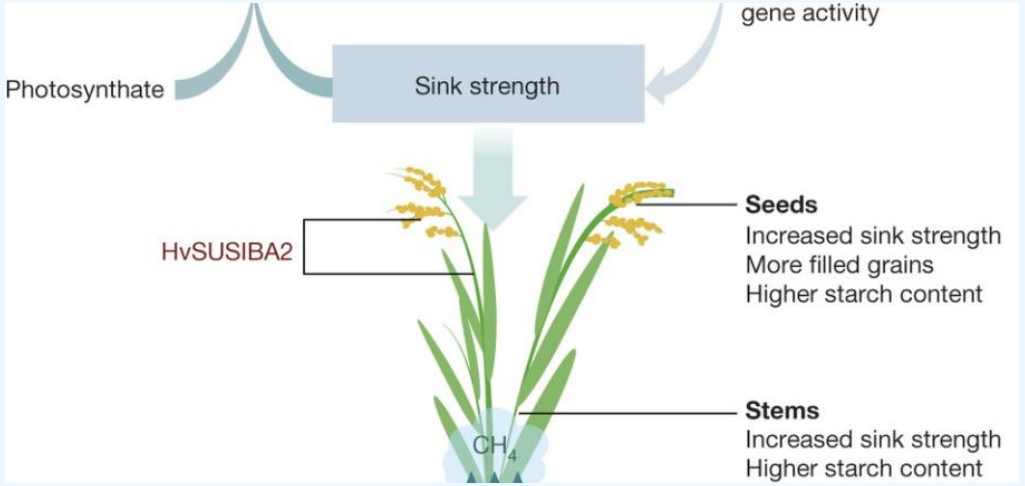
Key Finding (Su et al., 2015, Nature)

Expression of barley SUSIBA2 transcription factor yields high-starch low-methane rice

A genetically modified rice variety was developed and published in Nature. This research marked a significant milestone in agricultural biotechnology.

Outstanding Results & Mechanism

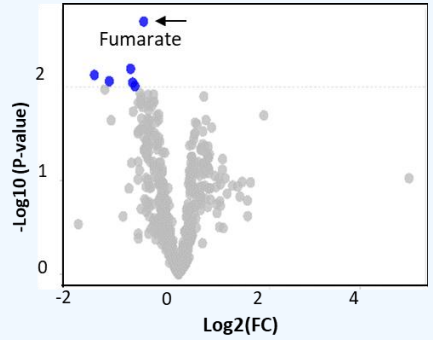
Methane Reduction:**90%** Starch Increase:**10%**



The diagram illustrates how SUSIBA2 redirects carbon flow from methane production in roots to starch synthesis in grains, achieving both environmental and yield benefits.

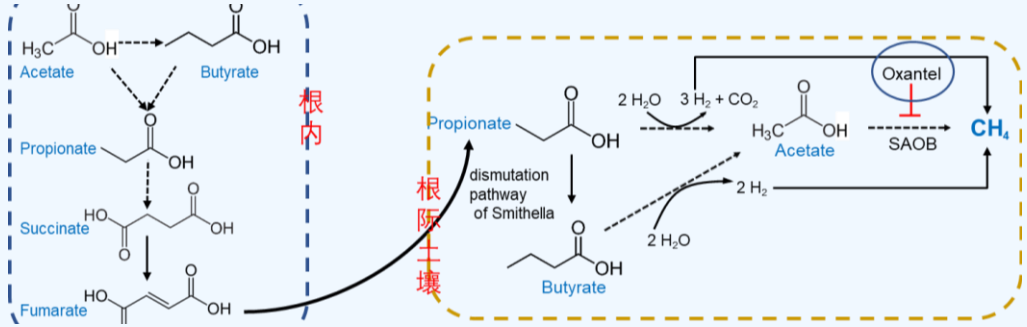
Fumarate: A Key Regulator of Methane Emissions

Key Difference: Identification of Fumarate

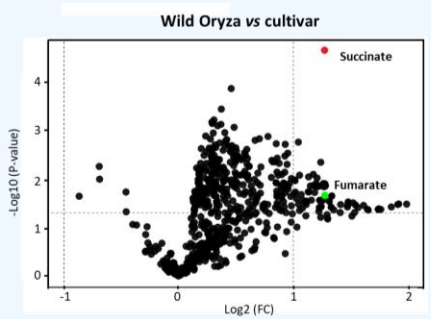


Fumarate was identified as the major rhizosphere metabolite difference between SUSIBA2 rice and its wild-type control (Jin et al. 2025, Mol Plant).

Fumarate: Carbon source



Mechanism: Electron Transfer & Redox

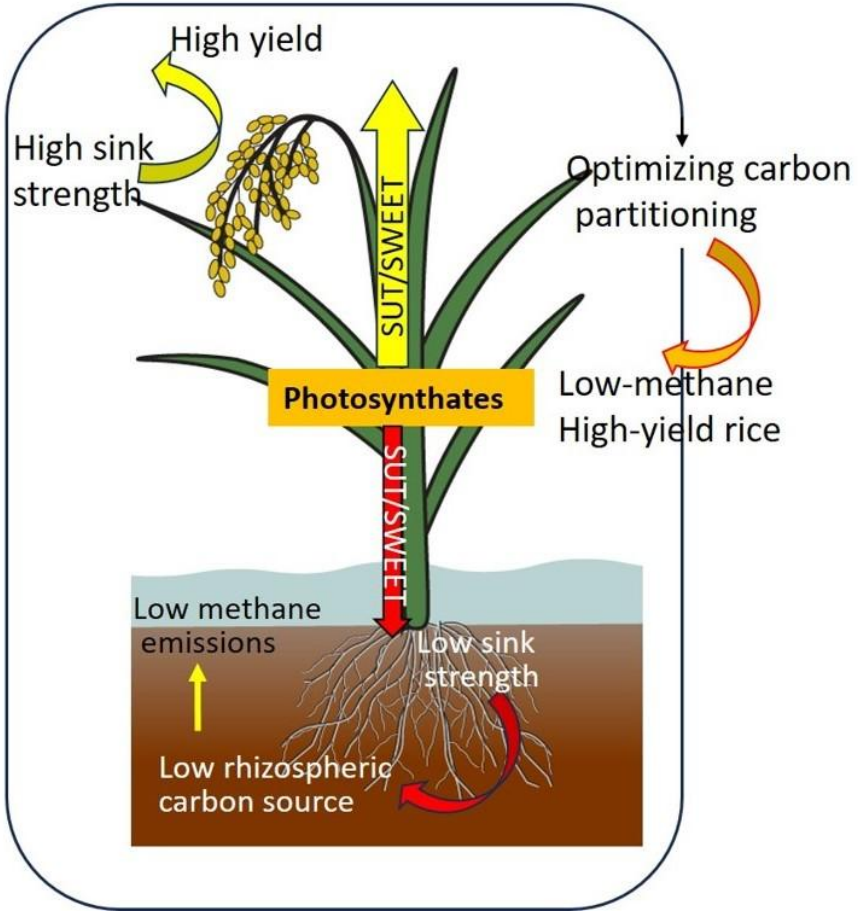


Wild rice rhizospheres exhibit more active fumarate metabolism and electron transfer capacity compared to cultivated rice (Hu et al. 2024b, Environment Int.).

Core Role of Fumarate

- **Carbon Source:** Major upstream carbon source maintaining energy supply for methanogens.
- **Electron transfer:** Acts as a terminal electron acceptor under anaerobic conditions, directly regulating methane production via redox reactions.

Carbon Source: Optimizing carbon partitioning creates low methane rice



Hu *et al*. 2024a, Sci Total Environ

- Low-methane rice has been developed

I: 70% reduction in methane emissions from paddy fields.

II: Yield is not lower than the average level of the main local cultivars.

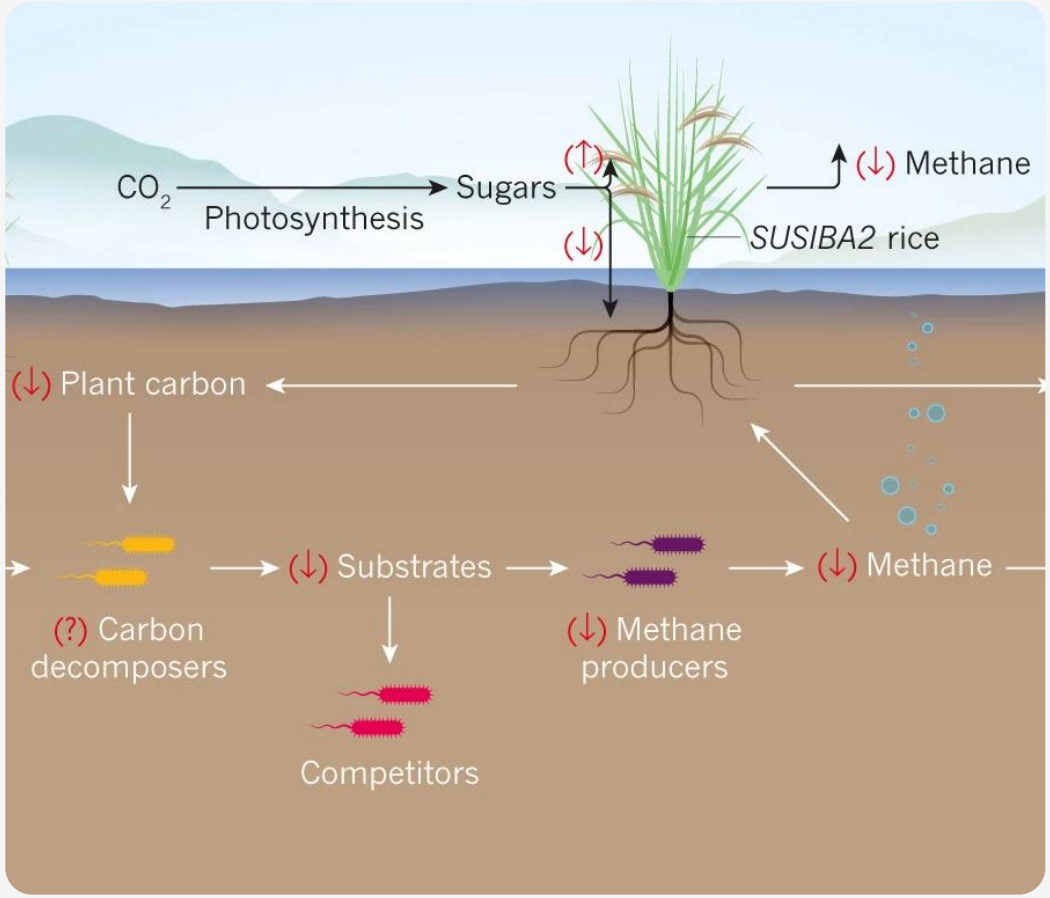
Conclusion and Future Outlook

Key Conclusion

Reducing paddy methane emissions is crucial for climate action. This strategy can be economically incentivized through carbon credits, creating a win-win for the environment and farmers.

Future Outlook

Explore key metabolites like fumarate and utilize wild rice genetic resources to develop new low-methane, high-yield rice varieties for sustainable agriculture.

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