A cyclical effect: More atmospheric CO2, more greenhouse gas per grain of rice

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Paddy field. Credit: Jim Hill, UC Davis.

More carbon dioxide in the atmosphere and rising temperatures cause rice agriculture to release more of the potent greenhouse gas methane (CH_4) for each kilogram of rice it produces, new research published recently in the online edition of *Nature Climate Change* reveals. "Our results show that rice agriculture becomes less climate friendly as our atmosphere continues to change. This is important, because rice paddies are one of the largest human sources of methane, and rice is the world's second-most produced staple crop," said Dr Kees Jan van Groenigen, Research Fellow at the Botany Department at the School of Natural Sciences, Trinity College Dublin, and lead author of the study.

Van Groenigen, along with colleagues from Northern Arizona University and the University of California in Davis, gathered all published research to date from 63 different experiments on rice paddies, mostly from Asia and North America. The common theme in the experiments was that they measured how rising temperatures and extra carbon dioxide in the atmosphere affect rice yields and the amount of methane that is released by rice paddies.

The research team used a technique called meta-analysis, a statistical tool for finding general patterns in a large body of experimental data. "Two strong patterns emerged when we analysed all the data: first, more CO_2 boosted emissions of methane from rice paddies, and second, higher temperatures caused a decline in rice yields", explained Professor Bruce Hungate of Northern Arizona University and co-author of the study.

Methane in rice paddies is produced by microscopic organisms that respire CO_2, like humans respire oxygen. More CO_2 in the atmosphere makes rice plants grow faster, and the extra plant growth supplies soil microorganisms with extra energy, pumping up their metabolism. Increasing CO_2 levels will also boost rice yields, but to a smaller extent then CH_4 emissions. As a result, the amount of CH_4 emitted per kilogram of rice yield will increase. Rising temperatures were found to have only small effects on CH_4 emissions, but because they decrease rice yield, they also increase the amount of CH_4 emitted per kilogram of rice. "Together, higher CO_2 concentrations and warmer temperatures predicted for the end of this century will about double the amount of CH_4 emitted per kilogram of rice produced.", explained Professor Chris van Kessel of the University of California in Davis and co-author of the study. "Because global demand for rice will increase further with a growing world population, our results suggest that without additional measures, the total CH_4 emissions from rice agriculture will strongly increase.".

However, the authors point out that there are several options available to reduce CH_4 emissions from rice agriculture. For instance, management practices such as mid-season drainage and using alternative fertilizers have been shown to reduce CH_4 emissions from rice paddies. Moreover, by switching to more heat tolerant rice cultivars and by adjusting sowing dates, yield declines due to temperature increases can largely be prevented, thereby reducing the effect of warming on CH_4 emissions per yield. "These findings, together with our own results really stress the need for mitigation and adaptation measures to secure global food supply while at the same time keeping greenhouse gas emissions in check." van Groenigen concluded.

Provided by Trinity College Dublin

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