Researchers: There is a need for more accurate accounting of nitrous oxide from agricultural crop residues

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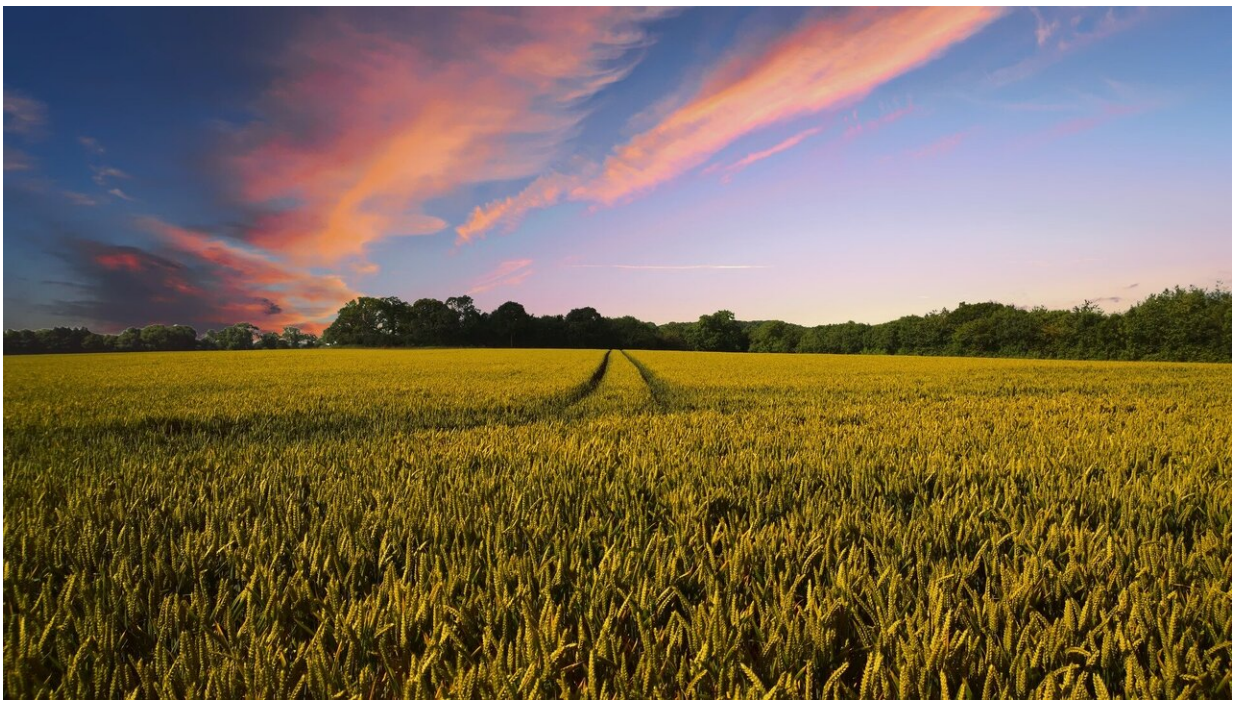

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There is a need for changing the way of accounting greenhouse gases from agriculture. The current inventory of nitrous oxide from plant residues relies solely on the amount of nitrogen in the residues, while crucial factors such as the degradability of plant residues are not

included. According to the researchers, this leads to misleading inventories, which also misrepresents possible mitigation measures.

Crop residues are an important resource in agriculture. They contribute carbon to the soil, increase soil fertility and play an important role in the agricultural ecosystem, but they also play a role in relation to energy supply and recycling of nutrients. Crop residues can be very diverse and have widely different composition and properties. They can be cover crops, grass, grass-clover, vegetables, straw, etc. They may consist of residues from roots or from aboveground crop parts.

"All in all, there is large diversity in the quality of the crop residues that are added to the soil as part of the general cultivation practice," says Professor and Department head Jørgen E. Olesen from the Department of Agroecology at Aarhus University.

He has headed a new scientific study highlighting the differences in crop residues and how they affect nitrous oxide emissions from agricultural fields in different ways.

"Crop residues are essential for maintaining soil fertility, and in addition, they play a major role in maintaining or increasing the carbon content in the soil. Unfortunately, they also contribute to the emission of nitrous oxide," says Jørgen E. Olesen.

Clash with current emission inventories

IPCC—The Intergovernmental Panel on Climate Change—prepares guidelines for how to make national inventories of greenhouse gas emissions, including nitrous oxide emissions, when crop residues are returned to the fields.

The IPCC is an international organization established in 1988 by the

World Meteorology Organization (WMO) and the United Nations Environment Program (UNEP). The purpose of the IPCC is to assess scientific knowledge about climate change, its causes, impacts and possible adaptation and mitigation strategies.

The IPCC plays a key role in gathering and assessing the latest scientific literature on climate change and preparing reports that inform politicians and decision-makers worldwide. IPCC reports are used as the basis for international climate negotiations and policy development.

The organization is known for publishing comprehensive assessments of climate science, including reports on greenhouse gases, sea level rises, temperature changes and other aspects of climate change.

The work of the IPCC therefore plays a crucial role in understanding and managing climate change at global level.

The IPCC's inventory method includes nitrous oxide from crop residues such as annual cereal and seed crops, root crops, vegetables, fodder crops and grassland renewal.

"Non-harvestable crops such as cover crops are not taken into account," explains Jørgen E. Olesen, who adds that the biochemical properties of crop residues and their degradability of carbon and nitrogen are also not included in the accounting of emissions.

"The current method only considers the nitrogen content in the plant residues, but our studies show that the degradability of carbon in plant residues actually is more important. There is therefore a need for an improved accounting method so that inventories are accurate and mitigation measures can be effective," says Jørgen E. Olesen.

Difference between ripe and unripe crop residues

According to the researchers, there may be large differences in how much nitrous oxide the crop residues emit.

"Many different factors come into play when you look at the extent of nitrous oxide emissions from crop residues. A very important factor is the concentration of degradable carbon and nitrogen. When the concentration is high, the potential for producing nitrous oxide also increases," says Jørgen E. Olesen.

You often see a high concentration of both easily degradable carbon and nitrogen in immature crop residues, such as cover crops, grass, legumes and vegetables, while mature crop residues such as straw do not have such high concentrations.

"A distinction between mature and immature crop residues could help to ensure a more accurate estimation of the short-term effects of crop residues on nitrous oxide emissions. For the more long-term effects, i.e., years and decades, we should account for the residual effects on soil quality and nitrogen content. They are affected by local climatic conditions, just as the soil conditions are of importance," says Jørgen E. Olesen.

Targeted mitigation of nitrous oxide emissions

"There is a critical need for new and targeted strategies when it comes to reducing nitrous oxide from crop residues. Globally, approx. 9% of agricultural emissions of nitrous oxide stem from the input of crop residues to the fields. However, such strategies require that the accounting of emissions from crop residues becomes more accurate," says Jørgen E. Olesen.

A distinction between mature and immature crop residues may be an

approach that, according to the researchers, could improve the accuracy of the inventories. It will also improve the possibilities of targeting and finding appropriate mitigation strategies.

"Reviewing how we calculate emissions from specific crop residues and determine the right time and place to use them requires more research. There are also important questions in the research into emissions from crop residues that we still need to answer," says Jørgen E. Olesen, who points out that there is a need for more research into:

- Develop and validate nitrous oxide emission factors for mature and immature crop residues
- Assess emissions from belowground residues from harvested crops
- Improve data on managing different types of crop residues, especially immature residues
- Evaluate long-term effects of crop residues inputs on nitrous oxide emissions

The research is published in the journal *Global Change Biology*.

More information: Jørgen E. Olesen et al, Challenges of accounting nitrous oxide emissions from agricultural crop residues, *Global Change Biology* (2023). DOI: 10.1111/gcb.16962

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