

N₂O Emissions from Agriculture

Luca Vitale*

National Research Council, Department of Biology, Agriculture and Food Sciences, Institute for Agricultural and Forestry Systems in the Mediterranean, Ercolano, Italy

***Corresponding Author:** Luca Vitale, National Research Council, Department of Biology, Agriculture and Food Sciences, Institute for Agricultural and Forestry Systems in the Mediterranean, Ercolano, Italy.

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Nitrous oxide (N₂O) represents one of the major greenhouse gases and its concentration in the atmosphere increased up to 340 ppb from pre-industrial period due to human activities. Arable soils contribute significantly (about 60%) to N₂O emission in the atmosphere, resulting the most important source of N₂O due to the large use of nitrogen fertilizers in order to increase crop yields [1].

In soils, N₂O emissions derive from two microbial processes: nitrification and denitrification. Nitrification, performed by chemoautotrophic bacteria, is the oxidation of NH₄⁺ to NO₃⁻ whereas denitrification, performed by heterotrophic bacteria and fungi, is the conversion of NO₃⁻ to N₂O and N₂.

Nitrification and denitrification are affected not only by NH₄⁺ and NO₃⁻ concentration, but also by other soil characteristics such as aeration, temperature, moisture, organic matter content and quality, and C/N ratio.

The oxidation of NH₄⁺ to NO₃⁻ by nitrification is an aerobic process: it increases under well soil aeration conditions and diminishes when the O₂ concentration is low; on the contrary, denitrification is an anaerobic process. Thus, N₂O is produced mainly by nitrification under aerobic or semi aerobic conditions whereas under anaerobic conditions N₂O is produced by denitrification.

Temperature and moisture affect soil N₂O emission by affecting microorganism's activity: N₂O emission increase with increasing soil temperature and moisture. For this latter, N₂O emission is mainly due to nitrification for water filled pore space (WFPS) values below 60%. For WFPS values ranging from 60 - 80%, denitrification represents the mainly process producing N₂O being small the number of soil pores filled with air.

Organic matter content and quality, as well as the C/N ratio in the soil also influence N₂O production. The supply to soil of labile carbon stimulates microbial growth and O₂ consumption generating anaerobic condition and promoting denitrification. Soils characterized by small C/N ratio produce higher N₂O emission than soil with high C/N ratio. This because low C/N ratio promotes mineralization of organic nitrogen to NH₄⁺ making more nitrogen available for nitrifying and denitrifying microorganisms.

In addition to environmental conditions, management practices affect N₂O emission from arable soils. Soil tillage decreases N₂O emission as consequence of lower soil moisture and improved soil aeration. Nitrogen fertilization and fertilizer type significantly affect N₂O emission. Dried organic manure promotes lower nitrous oxide production than mineral fertilizer likely due to the reduced C and N availability in the soil, as a consequence of slow mineralization of organic component that limit available N for biological transformations leading to N₂O evolution [2,3]. The addition to fertilizers of nitrification inhibitors mitigates soil N₂O emission by suppressing microbial activity for a period of time depending on soil type, moisture and temperature [2-4].

Bibliography

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