GCB 重要综述 ｜N_2O 排放是否抵消掉土壤有机碳固存所带来的益处？（转）

信息：

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摘　要：《巴黎协定》目标是到 2100 年将全球变暖限制在 2°C 以下，甚至是在 1.5°C 以下，因此必须大幅度减少温室气体排放。然而目前工作还不足够，仍需要大规模地部署其他气候缓解策略。其中，增加土壤有机碳（SOC）储量是一个重要的杠杆，因为土壤中的碳可以长期储存，且实现这一目标的土地管理措施存在并已得到广泛测试。然而，农业土壤还是强温室气体氧化二氮（N_2O）的重要来源，SOC 的增加可能会影响 N_2O 排放，在多数情况下可能会导致 N_2O 排放增加，从而抵消了 SOC 储量增加所带来的气候变化益处。在此，本研究回顾并综述了增加 SOC 储量的主要农业管理措施。本研究评估了可被固存的 SOC 数量以及由此产生的 N_2O 排放变化，以更好地估算这些管理方案的气候效益。根据从已发表的 Meta 分析文章中获得的定量数据以及当前理解水平，本研究得出的结论是，如果不考虑相关的 N_2O 排放，则通常高估了 SOC 储量增加所带来的气候缓解效益。但除减少耕作外，N_2O 排放不可能完全抵消掉土壤有机碳固存所带来的益处。一些农田管理措施（如生物炭或非热解碳改良剂施用等）甚至可能会减少 N_2O 排放。

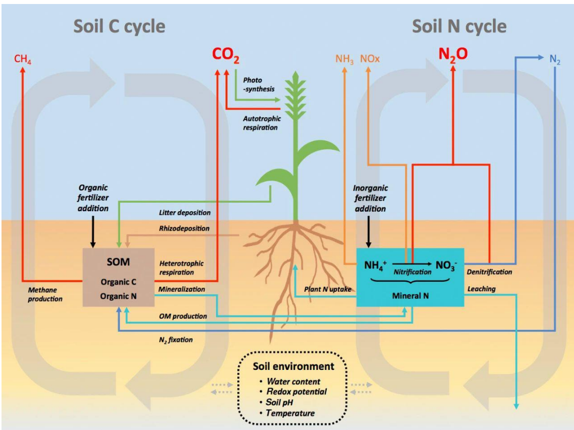

Fig. 1 A schematic representation of C–N interactions in the terrestrial ecosystem. Note thatbiological nitrogen fixation and denitrification are process performed by microorganisms that also need C as substrate and that the schematic is more representative ofagroecosystems.

Table 1 Summary of the effects of management practices on soil organic carbon (SOC) storage and N_2O emissions

Management practice	Effect on soil C stocks	Effect on N_2O emissions
Reduced tillage/zero tillage	Reduced C loss/increased C inputs to soils when associated with a reduced weed management (Angers & Eriksen-Hamel, 2008; Virto et al., 2011)	Promote denitrification (anaerobiosis; Mei et al., 2018)
Erosion control (contour plowing, terracing)	Reduced C loss (Moraru & Rusu, 2010)	Unclear
Addition of non-pyrogenic organic amendments (compost, manure, crop residues)	Increased C input but in some cases (e.g. manure) rather a transfer from one terrestrial location to another than a transfer of C from atmosphere to soil (Diacono & Montemurro, 2011)	Enhanced denitrification rate (via anaerobiosis and the supply of electron donors), and soil N availability (Charles et al., 2017)
Use of cover crops	Reduced C loss/increased C input (Poeplau & Don, 2015)	Decreased denitrification because of N uptake by plants; may be compensated for by N inputs from biological nitrogen fixation (Lugato, et al., 2018; Thapa et al., 2018)
Biochar	Increased C input (Lehmann et al., 2006)	Decreased nitrification due to adsorption of mineral N with biochar (Borchard et al., 2019)
Agroforestry	Increased C input, reduced C loss, increased aggregate stability (Feliciano et al., 2018)	Decreased denitrification (lower soil moisture, increased soil porosity, increased nitrogen uptake), except for N_2-fixing trees (increasing soil available N; Kim et al., 2016)

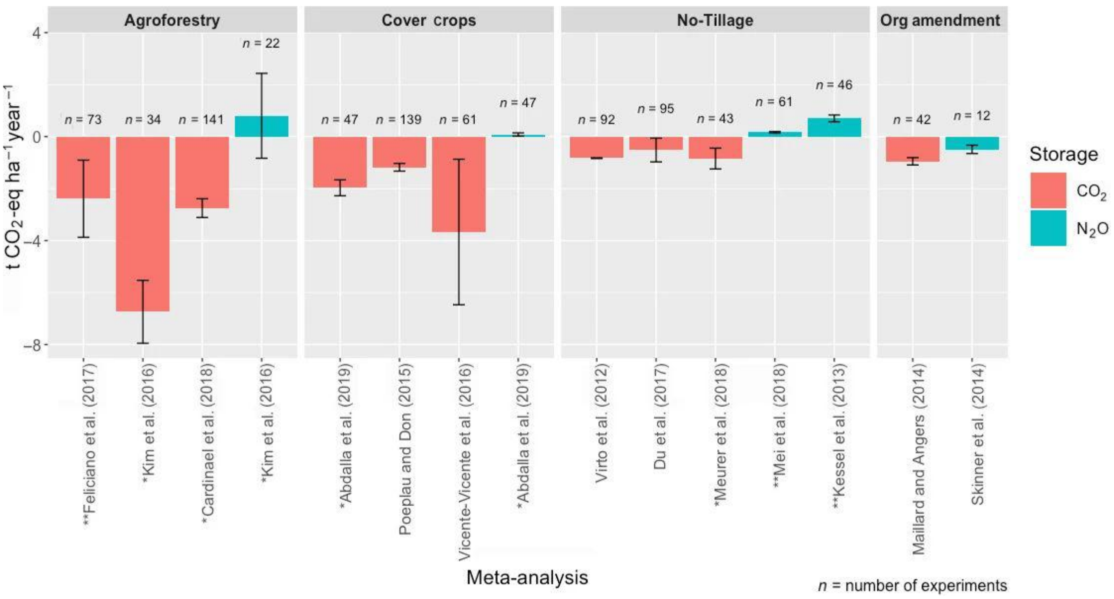

Fig. 2 Estimation of the soil organic carbon storage and N_2O emissions of land‐based mitigation options expressed in CO_2 equivalents. Negative values indicate a net reduction in GHG emissions in terms of CO_2 equivalents, while positive values show a net increase of CO_2 equivalent emissions. All values refer to the difference between the land‐based mitigation option in question and a ‘control’ land (e.g. no‐tillage vs. conventional tillage). For agroforestry, the control land is cropland and different types of agroforestry systems were considered. NB: In Kim et al. (2016) the majority of soil C storage data comes from intercropping, improved fallows and rotational woodlots, which are systems with high tree density. This could partially explain the very high estimation of soil C storage found in Kim et al. (2016) compared to other papers. Organic amendments do not include biochar. The control used for comparison with organic amendments is an experiment managed with inorganic fertilizers. For cover crops meta‐analysis, Vicente‐Vicente et al. (2016) only consider Mediterranean woody crops (olive, almond and vineyards), which could also explain the large soil C rates estimated. Uncertainty is given as standard error (SE) for every paper. If it was provided as a confidence interval (CI) or standard deviation (SD) it has been adequately transformed to unify the units.

(*Reviews; **For these meta‐analysis the values reported in the graph have been recalculated as the weighted mean across all experiments, from the database provided by the authors, because the values coming from the papers could not be used as they were reported as a percentage only) (Abdalla et al., 2019; Du et al., 2017; Skinner et al., 2014; Vicente‐Vicente et al., 2016)

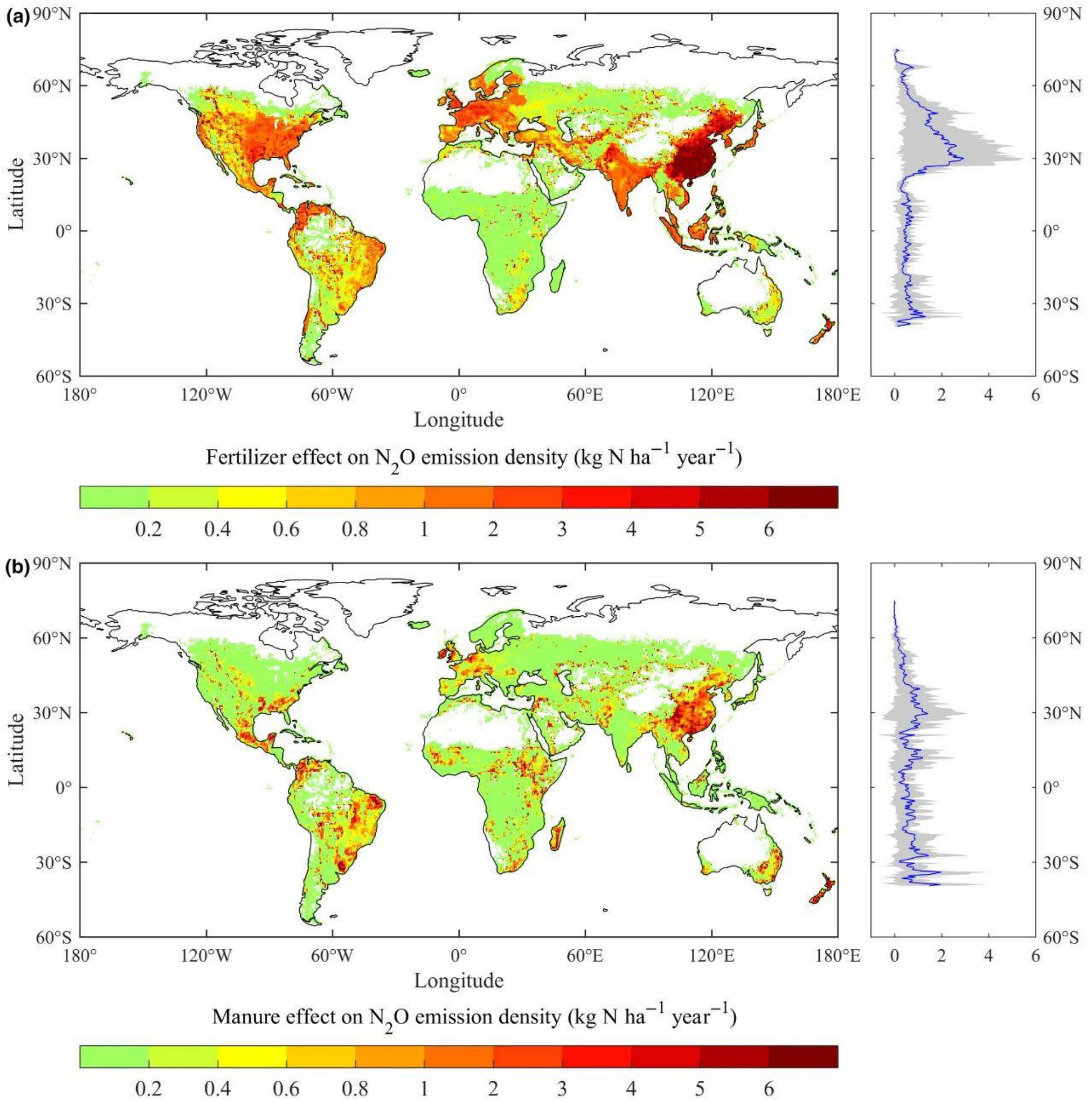

Fig. 3 Spatial and latitudinal patterns of contributions of fertilizer (a) and manure (b) on cropland soil N_2O emissions obtained during the global N_2O Model Intercomparison Project(Tian, et al., 2018). Average over the 2006–2015 period.

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