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Achieving high crop yields with low nitrogen emissions in global agricultural input intensification

Wenfeng Liu (1,2), Hong Yang (2), Christian Folberth (3), Christoph Müller (4), Philippe Ciais (1), Karim C. Abbaspour (2), and Rainer Schulin (5)

(1) Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CEA-CNRS-UVSQ, Université Paris-Saclay, Gif-sur-Yvette, France (wenfeng.liu@lsce.ipsl.fr), (2) Eawag, Swiss Federal Institute of Aquatic Science and Technology, Duebendorf, Switzerland, (3) Ecosystem Services and Management Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria, (4) Potsdam Institute for Climate Impact Research, Potsdam, Germany, (5) ETH Zürich, Institute of Terrestrial Ecosystems, Zürich, Switzerland

Increasing demand for food is driving a worldwide trend of agricultural input intensification. However, there is no comprehensive knowledge about the interrelations between potential yield gains and environmental trade-offs that would enable the identification of regions where input-driven intensification could achieve higher yields, yet with minimal environmental impacts. We explore ways of enhancing global yields, while avoiding significant nitrogen (N) emissions (N_e) by exploring a range of N and irrigation management scenarios. The simulated responses of yields and N_e to increased N inputs (N_{in}) and irrigation show high spatial variations due to differences in current agricultural inputs and agro-climatic conditions. Nitrogen use efficiency (NUE) of yield gains is negatively correlated with incremental N_e due to N_{in} additions. Avoiding further intensification in regions where high fractions of climatic yield potentials, $\geq$80%, are already achieved is key to maintain good NUE. Depending on the intensification scenarios, relative increases in N_e could be reduced by 0.3–29.6% of the baseline N_e with this intensification strategy as compared to indiscriminate further intensification, at the cost of a loss of yield increases by 0.2–16.7% of the baseline yields. In addition, irrigation water requirements and N_{in} would dramatically decrease by considering this intensification strategy.