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Interactive comment on "N_2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels" *by* P. J. Crutzen et al.

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The simple but nevertheless convincing top down analysis of this paper by Crutzen et al. shows that biofuel may have a negative greenhouse gas balance. We agree that it is crucial to appropriately consider the counteracting effect of inevitable N2O emissions when producing biofuel, and this has obviously been neglected by many promoters of subsidies and regulations in favor of massif biofuel production. Still, we have some reservations about the calculations presented by Crutzen et al., which we think over-

estimate the compensating effect of N2O emissions. The authors argue that the IPCC methodology seriously underestimates N2O emissions of agriculture. However, the discrepancy between the emission factor of 3-5% derived by Crutzen et al. and the IPCC emission factor of 1% (or about 1.7% including indirect emissions) for fertilizer application is only due to a difference in the concepts.

As pointed out by Crutzen et al. their absolute N2O source attributed to agriculture of 4.3-5.8 Tg N2O-N/year (derived from global present and pre-industrial budget considerations) agrees well with the result of Mosier et al. (1998). Yet, as we understand, the latter result was indeed calculated following IPCC methodology and thus there is a good agreement between both approaches concerning absolute emission values. The apparent discrepancy in the emission factors result from two different concepts (definitions) applied: Crutzen et al. relate the total agricultural N2O emission to the "newly-fixed nitrogen" (synthetic fertilizer and biologically fixed N) whereas the IPCC methodology relates N2O emissions to all kinds of N-fertilizer applied in the field. According to Mosier et al. (1998), only about one third of N2O emissions (direct and indirect) are due to newly-fixed N fertilizer, another third is due to the application of recycled organic fertilizer (plant residues and manure) and the last third is due to specific waste management in animal production. Thus about two thirds of agricultural N2O emissions are due to internal recycling of nitrogen in animal production or by using plant residues as fertilizer. This means that there is no indication of an important unconsidered N2O emission in the IPCC methodology. The higher emission factor derived by Crutzen et al. is due to the fact that, on a global average, each newly fixed nitrogen molecule is used about two times as fertilizer (and also flows through animal production systems) before it undergoes total denitrification.

It is therefore important to consider the fate of the plant N content when producing biofuels. If it is assumed that, apart from the field growth, no additional N2O is emitted in the technical process of biofuel production, the plant N is either converted to N2 or it is contained in organic residues that can be used again as N-fertilizer (thus reducing

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the demand for new synthetic fertilizer). Consequently, we think that a total IPCC based emission factor of about 1.7% (covering direct and indirect N2O emissions) is adequate for the calculation of the greenhouse gas budget of biofuel production (life cycle analyses).

This indicates that bioenergy production systems can be optimized to achieve a net climate cooling effect. However, such an optimization will probably conflict with economical optimization. It is therefore crucial that regulation and subsidies are coupled to optimized practice that is based on solid scientific knowledge. The currently booming biofuel market is not at all a hopeful signal in this direction. More severely, large areas of fertile land with sufficient water supply will be used for energy production instead of feeding the growing world population. The present discussion adds further evidence that energy saving is the best way to mitigate greenhouse gas emissions.

References:

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