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Consequences of agro-biofuel production for greenhouse gas emissions

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BioConcens

A 4-year interdisciplinary project

Energy production and energy use in organic agriculture (OA) need to be addressed in order to reduce the reliance on non-renewable fossil fuels and minimize greenhouse gas emissions. Thus, there is an obligation to find consensus between the apparent opposing aims of renewable (bio) energy production and soil fertility in OA. The BioConcens project aims at designing and evaluating a combined concept for biomass and bio-energy production in OA, while considering soil fertility and greenhouse gas emissions.

Background

Currently CO_2 from fossil fuel combustion accounts for 57 % of the global greenhouse gas emission, where as the strong greenhouse gases nitrous oxide (N_2O) and methane (CH_4) contribute with 8 % and 14 %, respectively (IPCC, 2007). Agricultural activity is the dominant source of N_2O, which is mainly associated with the use of nitrogen based fertilizers in agricultural production.

Replacing fossil fuel-derived energy by biomass-derived energy is commonly and with increasing emphasis proposed as a mean to mitigate the CO_2 emissions. However, a recent analysis of global emission data proposes that accelerated emissions of N_2O associated with the production of biomass for bio-fuel purposes will outweigh the avoided emissions of fossil fuel-derived CO_2 (Crutzen et al., 2008).

Objectives and experimental setup

Study the effect on N_2O and CH_4 emissions when residues from bio-energy production are recycling as organic fertilizer for a maize energy crop

Assess sustainability in terms of greenhouse gasses for co-production of bio-ethanol and bio-gas from maize

Materials applied by simulated direct injection (150 kg N ha^{-1})

- Untreated cattle slurry
- Degasified slurry + degasified maize
- Degasified slurry + degasified grass-clover
- Grass-clover as green manure
- Control

N_2O and CH_4 emissions and energy crop yield

Very large amounts of N_2O were emitted after field application of cattle slurry and two different mixtures of degasified materials. Degasified slurry + maize gave rise to the largest cumulated N_2O loss during two months (Fig. 1).

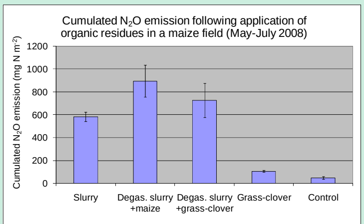


Fig. 1

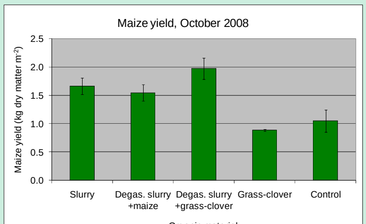
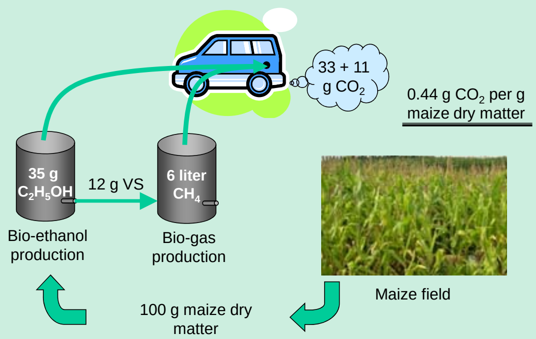


Fig. 2

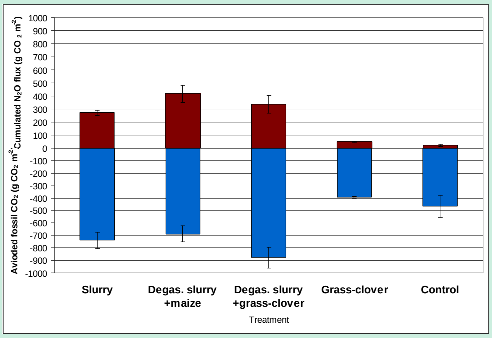
High CH_4 emissions were also measured from plots receiving slurry and degasified materials, but the peak only lasted a few days. A significantly larger maize biomass was harvested in the plots receiving the three slurry-based fertilizers than in the control (Fig. 2).

Amount of biofuels produced from the maize biomass?



100 g maize dry matter is fed into the bio-ethanol reactor. Here 35 g ethanol is produced. The effluent from the bio-ethanol reactor contains about 12 g volatile solids, which gives rise to 6 liter of CH_4 the bio-gas reactor. When these biofuels are combusted they result in 33 + 11 g CO_2. Thus, when 1 g of maize biomass is harvested we can produce biofuels that replace 0.44 g fossil fuel-derived CO_2.

Greenhouse gas balance for production of maize biofuels



For most of the treatments it appears that the N_2O emission associated with the cultivation of the maize crop (red bar; in CO_2-equivalents) offsets a considerable faction of the fossil CO_2, which is avoided by producing the biofuels (blue bar). Thus, field emissions of especially N_2O ought to be taken into account when assessing the sustainability in terms of greenhouse gasses of a biofuel production system.

Acknowledgements

The project is linked to the Danish Research Centre for Organic Farming and funded under the research programme: Research in Organic Food and Farming, International Research Co-operation and Organic Integrity (DARCOF III 2005-2010). Co-ordinated by Head of Programme, E.S. Jensen, Biosystems Division, Risø-DTU

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Poster presented at EnergyDTU Internal Conference December 11, 2008

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