Consequences of field N2O emissions for the environmental sustainability of plant-based biofuels produced within an organic farming system - DTU Orbit (03/01/2019)

Consequences of field N2O emissions for the environmental sustainability of plant-based biofuels produced within an organic farming system

One way of reducing the emissions of fossil fuel-derived carbon dioxide (CO2) is to replace fossil fuels with biofuels produced from agricultural biomasses or residuals. However, cultivation of soils results in emission of other greenhouse gases (GHGs), especially nitrous oxide (N2O). Previous studies on biofuel production systems showed that emissions of N2O may counterbalance a substantial part of the global warming reduction, which is achieved by fossil fuel displacement. In this study, we related measured field emissions of N2O to the reduction in fossil fuel-derived CO2, which was obtained when agricultural biomasses were used for biofuel production. The analysis included five organically managed feedstocks (viz. dried straw of sole cropped rye, sole cropped vetch and intercropped rye–vetch, as well as fresh grass–clover and whole crop maize) and three scenarios for conversion of biomass into biofuel. The scenarios were (i) bioethanol, (ii) biogas and (iii) coproduction of bioethanol and biogas. In the last scenario, the biomass was first used for bioethanol fermentation and subsequently the effluent from this process was utilized for biogas production. The net GHG reduction was calculated as the avoided fossil fuel-derived CO2, where the N2O emission was subtracted. This value did not account for fossil fuel-derived CO2 emissions from farm machinery and during conversion processes that turn biomass into biofuel. The greatest net GHG reduction, corresponding to 700–800 g CO2 m⁻², was obtained by biogas production or coproduction of bioethanol and biogas on either fresh grass–clover or whole crop maize. In contrast, biofuel production based on lignocellulosic crop residues (i.e. rye and vetch straw) provided considerably lower net GHG reductions (≤215 g CO2 m⁻²), and even negative numbers sometimes. No GHG benefit was achieved by fertilizing the maize crop because the extra crop yield, and thereby increased biofuel production, was offset by enhanced N2O emissions.
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 0.162 SNIP 0.158
Web of Science (2010): Impact factor 2.419
Original language: English
Keywords: Environment and climate, Bioethanol and/or biogas, Carbon sequestration, Digestate recycled as fertilizer, Emission factor, Fossil fuel displacement, Grass-clover, Methane, Nitrous oxide, Rye and vetch straw, Whole crop maize, Agronomy, Energy, Nitrous-oxide emissions, Greenhouse-gas emissions, Vicia-villosa roth, Crop residues, Chemical-composition, Anaerobic-digestion, Biogas production, Swine manure, Clover-grass, Biomass
DOIs:
10.1111/j.1757-1707.2011.01132.x
Source: orbit
Source-ID: 312973
Research output: Research - peer-review › Journal article – Annual report year: 2011