Modelling non-CO2 greenhouse gas emissions and mitigation potentials of Austrian farms

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Introduction

Agriculture is responsible for a large share of the non-CO2 greenhouse gas (GHG) emissions, both globally and in Austria. Non-CO2 GHG emissions include methane (CH4) and nitrous oxide (N2O) as well as reactive trace gases such as ammonia (NH3) [1]. CH4 originates primarily from enteric fermentation of ruminants and during manure storage. N2O and NH3 are produced in microbial processes of soils and manure [2]. The literature proposes a variety of mitigation measures while farm specific calculations of marginal abatement costs (MACs) are still limited. We have extended and applied the Farm Optimization Model FAMOS [3] to account for non-CO2 GHG emissions and to compute MACs for selected mitigation measures at the farm level, including alternative manure storage systems, feeding rations, crop rotations, tillage, and fertilization intensities.

Data and Methods

FAMOS is a mixed-integer linear farm optimization model implemented in GAMS for the Austrian farms [5]. FAMOS maximizes farm net returns and operates within the constraints of the farm’s resource endowments. Agronomic production relationships (e.g., fertilizer and feed balances, crop rotations) and legal compliances (e.g., CAP measures and payments) are taken into account. The non-CO2 GHG emission accounting module follows the guidelines for national GHG inventories, as provided by the Intergovernmental Panel on Climate Change [2,6]. Emissions beyond the farm gate are not quantified.

Results: Non-CO2 emissions of alternative feeding rations in dairy farming

- The nutritional content of feeding rations (FR; such as crude protein (CP), crude ash (CA) and feed digestibility) affects non-CO2 emissions from livestock and manure management.
- The non-CO2 emissions are caused along the chain of emission sources.
- CH4 emissions from manure management are higher for a feeding strategy without grazing compared to a feeding strategy with grazing and with higher shares of concentrate feed in the feeding ration (FR 2A, FR 2B).
- Direct and indirect N2O emissions from manure management are lower for feed rations consisting of higher shares of concentrate feed (FR 2A, FR 2B).
- Feeding rations affect the availability of nitrogen for its application to the soil.

Conclusions and outlook

- Feeding rations need to be adjusted based on livestock performance and resource endowments of a farm in order to reduce non-CO2 emissions.
- Data on livestock characteristics and performance is needed to formulate feed rations for their application in the farm optimization model.
- The reduction of non-CO2 emissions at the farm level requires a holistic approach due to the dependencies of emission sources.
- Data on e.g., the composition of feeding rations are necessary for an accurate representation of non-CO2 emissions of alternative farm management practices in FAMOS.

References