

Modelling greenhouse gas emissions at farm level across Switzerland

Jérôme Schneuwly, Anina Gilgen & Daniel Bretscher
 Agroscope, 8046 Zürich, Switzerland; www.agroscope.ch

Introduction & Background

- Agricultural greenhouse gas (GHG) emissions make up for **14%** of total Swiss GHG emissions.¹
- **Methane** emissions from enteric fermentation are responsible for 62% of total agricultural emissions.²
- To track the development of different environmental indicators, the **monitoring of the agri-environmental system of Switzerland (MAUS)** is carried out.
- Within MAUS, the **Swiss Ammonia and Greenhouse Gas Emission (SAGE) model** was developed to calculate farm-scale, yearly, management-influenced emissions (Fig. 1).

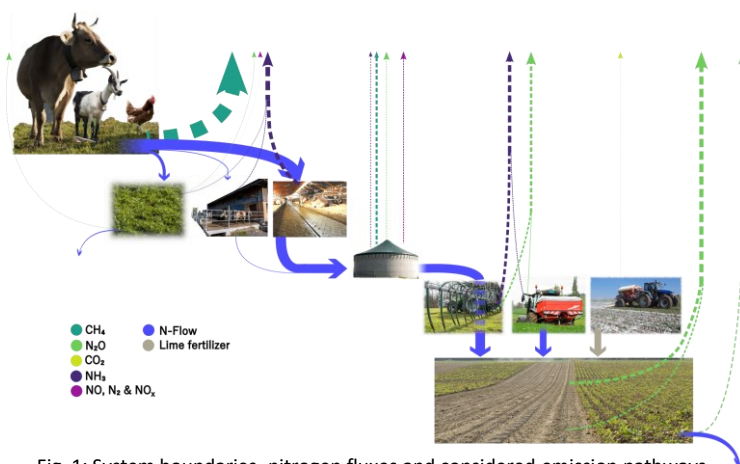


Fig. 1: System boundaries, nitrogen fluxes and considered emission pathways within the SAGE model.³

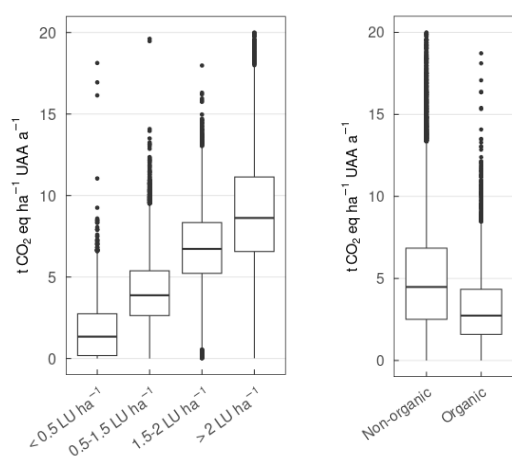


Fig. 2: Total GHG emissions per farm and ha UAA for different livestock densities and production systems.

Method

- The core of the model calculates a **nitrogen cascade** of farmyard manure from excretion to application.
- All GHG emissions according to the **IPCC system boundaries** are considered, following the national greenhouse gas inventory under the UNFCCC.
- **Revised** methodologies and emission factors were implemented.
- **Multiple existing data sources were linked** to deduce relevant farm specific input parameters.
- **Farm-specific information** was considered with first priority, otherwise typical regional or production system specific average values were calculated from other datasets (e.g. surveys).

- GHG emissions **increase with larger animal densities** (Fig. 2), generally due to higher CH_4 emissions and nitrogen excretions. Depending on the farm type, **feeding** or **mineral fertilizer** application also have a major influence on emissions.
- **Regions** with high GHG emissions are characterized by above-average animal densities (Fig. 3).
- Calculations resulted in mean national agricultural GHG emissions of **5.5 t CO_2eq / ha UAA and year**.
- Total emissions amount to **6.1 Mt CO_2eq** , which is very close to the 5.9 Mt CO_2eq of the national GHG inventory.

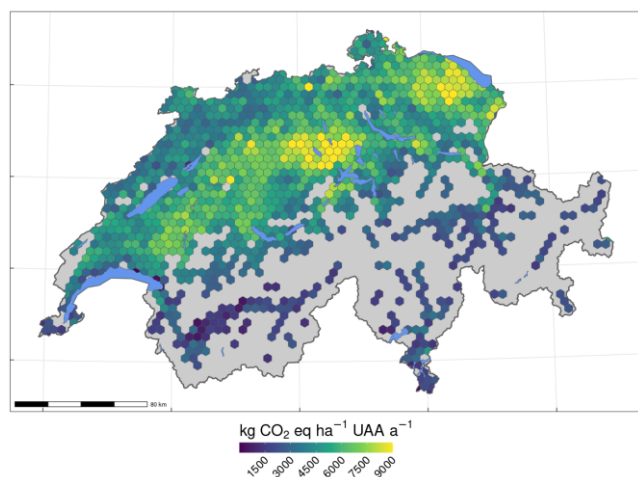


Fig. 3; Mean GHG emissions across Switzerland for entities with more than six farms.

Summary

Farm-level calculations allow to monitor the effects of management changes on **GHG emissions** and to summarize the results at different geographical resolutions. Sensitivity analyses of the input variables showed a large influence of **animal numbers, feeding** and **mineral fertilizer** application on emissions. Whereas uncertainties in the input datasets showed only limited effect on total national emissions, in some cases substantial differences at farm level occurred. **Newly available data sources**, such as farm specific mineral fertilizer applications, will successively be implemented to further refine the calculations.

1 FOEN, 2023a: Kenngrößen zur Entwicklung der Treibhausgasemissionen in der Schweiz 1990–2021. Federal Office for the Environment, Bern.
 2 FOEN, 2023b: Switzerland's Greenhouse Gas Inventory 1990–2021: National Inventory Document. Submission of April 2023 under the United Nations Framework Convention on Climate Change. Federal Office for the Environment, Bern.
 3 Pictures by Agroscope (Gabriela Brändle) and bodenkalk.at (02.04.2024)