

► Project *brief*

Thünen Institute of Climate-Smart Agriculture

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Update and improvement of GAS-EM modules for calculating emissions from animal husbandry

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- **The Thünen Institute of Climate-Smart Agriculture uses the GAS-EM model to calculate emissions of greenhouse gases, air pollutants and particulate matter from agriculture for the annual German emission inventories.**
- **The GAS-EM modules for dairy cows, calves, heifers and male beef cattle have been updated regarding calculation of energy requirements and feed intake to take into account improved data availability and developments in animal husbandry practice.**
- **The updated modules mainly calculate lower animal excretions and thus lower emissions of greenhouse gases and ammonia from German animal husbandry.**

Background and aims

The Thünen Institute of Climate-Smart Agriculture prepares the national inventories for emissions of greenhouse gases, air pollutants and particulate matter from agriculture annually. The emissions are calculated with the GAS-EM model. A central part of the model are modules for calculating emissions from animal husbandry. An update was considered necessary for the modules for dairy cows, calves, heifers and male beef cattle in order to account for changed data availability and developments in the practice of animal husbandry.

Approach

The previous dairy cow module was developed in 2009. The modelling of feeding was based on information from the feeding advisory service of the Lower Saxony Chamber of Agriculture (Landwirtschaftskammer Niedersachsen) and a basic feed formula from the German Agricultural Society (Deutschen Landwirtschafts-Gesellschaft, DLG) from 1986. The data on nutrient contents came from various literature sources. With the new dairy cow module, the standard recommendations published by the DLG in 2005 and 2014 on the feeding of German dairy cows are adopted. Consistent and complete data sets of the nutrient contents are included. They were made available to the Thünen Institute through direct expert contact.

In the new dairy cow module, the energy requirements needed to calculate the amount of feed intake are calculated exclusively based on the approach of the experts from GfE (Gesellschaft für Ernährungsphysiologie, Ausschuss für Bedarfsnormen / Society for Nutritional Physiology, Committee for Demand Standards) and DLG. The animal weight is an important input parameter. The initial weight (weight after first calving), which was too high in the previous module, was updated after an investigation by KTBL

(Kuratorium für Technik und Bauwesen in der Landwirtschaft / Association for Technology and Structures in Agriculture). The calf birth weight was increased to the standard value of 45 kg in accordance with DLG. In addition, the methodology for taking into account depression in digestibility with increasing levels of performance was revised.

The increase in calf birth weight also required a modification of the calf module. This was not possible with the previous calf module because it was based on fixed parameter values from the literature. For this reason, the calf module was largely renewed using DLG expert recommendations on energy requirements and feeding.

For heifers a comparison with the currently valid DLG expert recommendations found that the previous module, the feed intake modelling of which was developed in 2010, calculated too high a proportion of grass silage intake and thus too high N excretions. In addition, the previous module did not take into account the increase of energy requirements due to grazing, leading to underestimation of feed intake. In the new heifer module, the calculation of energy requirements and feeding has been adapted to the specifications of the GfE and DLG experts. In addition, the heifers were divided into the two sub-categories of dairy heifers and slaughter heifers in order to better take into account the differences in energy requirements, feed consumption and excretions by separate emission calculations.

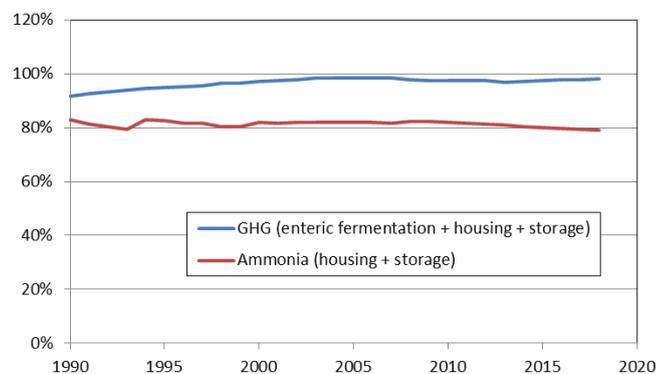
In the module of male beef cattle, the feed parameters have been updated in the same way as in the other modules. In addition, the modelling of the excrement flow into manure storage was revised.

Results

The updated modules for dairy cows, calves, heifers and male beef cattle mainly result in lower excretions and thus also

lower emissions of greenhouse gases and ammonia compared to the previous modules. In the case of heifers (dairy heifers and slaughter heifers considered together), the sum of greenhouse gases emitted per animal place from enteric fermentation and manure management (i.e. from housing and manure storage) is reduced by around 17% on average across Germany and the inventory time series 1990 - 2018; for dairy cows and male beef cattle, the reduction is a little over 3%, while for calves no noteworthy changes were found. The ammonia emissions arising from manure management per animal place decrease in spatial and temporal mean by around 19% for dairy cows, by 15% for calves and by 17% for heifers; the reduction for male beef cattle is approximately 3%.

The updated modules have already been used in the 2021 emission reporting, which was prepared in the second half of 2020.



Comparison of the annual emissions of greenhouse gases (GHG, in CO₂ equivalents) and ammonia calculated per dairy cow for the years 1990 - 2018: New calculation results in % of previous results

Source: Own illustration

Further Information

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