Chapter 5 - NFR 3 - Agriculture (OVERVIEW)

NFR-Code	Name of Category
3.B	3.B Manure Management
3.D	3.D Agricultural Soils
3.F	3.F Field Burning Of Agricultural Residues
3.I	3.I Agricultural: Other

Short description

Emissions occurring in the agricultural sector in Germany derive from manure management (NFR 3.B), agricultural soils (NFR 3.D) and agriculture other (NFR 3.I). Germany does not report emissions in category field burning (NFR 3.F) (key note: NO), because burning of agricultural residues is prohibited by law (see Vos et al., 2024)[1)].

The pollutants reported are:

- ammonia (NH_3),
- nitric oxides (NO_x),
- volatile organic compounds (NMVOC),
- particulate matter ($PM_{2.5}$, PM_{10} and TSP) and
- hexachlorobenzene (HCB).

No heavy metal emissions are reported.

The calculations for the present IIR 2024 were finished before the release of the EMEP (2023) guidebook. Therefore, methodological changes in the EMP (2023) guidebook were not considered for the present submission.

In 2022 the agricultural sector emitted 469.3 Gg of NH_3, 101.3 Gg of NO_x, 287.1 Gg of NMVOC, 59.1 Gg of TSP, 33.1 Gg of PM_{10} and 5.3 Gg of $PM_{2.5}$ and 0.65 kg HCB. The trend from 1990 onwards is shown in the graph below. The sharp decrease of emissions from 1990 to 1991 is due to a reduction of livestock population in the New Länder (former GDR) following the German reunification. The increase of NH_3 emissions since 2005 is mostly due to the expansion of anaerobic digestion of energy crops, especially the application of the digestion residues. This emission source also affects NO_x emissions. The decrease of NH_3 emissions since 2015 is mostly due to a decline in the amounts of mineral fertilizer sold and stricter regulations concerning application of urea fertilizers, as well as declining livestock numbers Further details concerning trends can be found in Vos et al., 2024, chapter “Emissions results submission 2024”.

As depicted in the diagram below, in 2022 91.6 % of Germany’s total NH_3 emissions derived from the agricultural sector, while nitric oxides reported as NO_x contributed 10.8 % and NMVOC 27.8 % to the total NO_x and NMVOC emissions of Germany. Regarding the emissions of $PM_{2.5}$, PM_{10} and TSP the agricultural sector contributed 6.3 % ($PM_{2.5}$), 18.0 % (PM_{10}) and 17.9 % (TSP) to the national particle emissions. HCB emissions of pesticide use contributed 14.1 % to the total German emissions.

Mitigation measures

The agricultural inventory model can represent several abatement measures for emissions of NH_3 and particles. The measures comprise:

- changes in animal numbers and amount of applied fertilizers
- air scrubbing techniques: yearly updated data on frequencies of air scrubbing facilities and the removal efficiency are provided by KTBL (Kuratorium für Technik und Bauwesen in der Landwirtschaft / Association for Technology and Structures in Agriculture) and from the agricultural census 2020. The average removal efficiency of NH_3 is 80 % for swine and 70 % for poultry, while for TSP and PM_{10} the rates are set to 90 % and for $PM_{2.5}$ to 70 % for both animal categories. For swine two types of air scrubbers are distinguished: first class systems that remove both NH_3 and particles, and second class systems that remove only particles reliably and have an ammonia removal efficiency of 20%.
- reduced raw protein content in feeding of fattening pigs: the German animal nutrition association (DVT, Deutscher Verband Tiernahrung e.V.) provides data on the raw protein content of fattening pig feed, therefore enabling the inventory to depict the changes in N-excretions over the time series. The time series is calibrated using data from

official and representative surveys conducted by the Federal Statistical Office.

- reduced raw protein content in feeding and feed conversion rates of broilers: the German animal nutrition association (DVT, Deutscher Verband Tiernahrung e.V.) provides data on the raw protein content of fattening broiler feed, and feed conversion rates of broilers. This makes it possible to model the changes in N-excretions over the timeseries.
- low emission spreading techniques of manure: official agricultural censuses survey the distribution of different manure spreading techniques and how fast organic fertilizers are incorporated into the soil. Germany uses distinct emission factors for different methods, techniques and incorporation durations.
- covering of slurry storage: agricultural censuses survey the distribution of different slurry covers. Germany uses distinct emission factors for the different covers.
- use of urease inhibitors: for urea fertilizer the German fertilizer ordinance prescribes the use of urease inhibitors or the direct incorporation into the soil from 2020 onwards. The NH_3 emission factor for urea fertilizers is therefore reduced by 70% from 2020 onwards for the direct incorporation, according to Bittman et al. (2014, Table 15)[2)]. For the use of urease inhibitors the NH_3 emission factor is reduced by 60% from 2020 onwards, see Vos et al. (2024), Chapter 5.2.1.2.

For NO_x and NMVOC no mitigation measures are included.

Reasons for recalculations

(see Chapter 8.1 - Recalculations)

The following list summarizes the most important reasons for recalculations. Recalculations result from improvements in input data and methodologies (for details see Vos et al. (2024), Chapter 1.3).

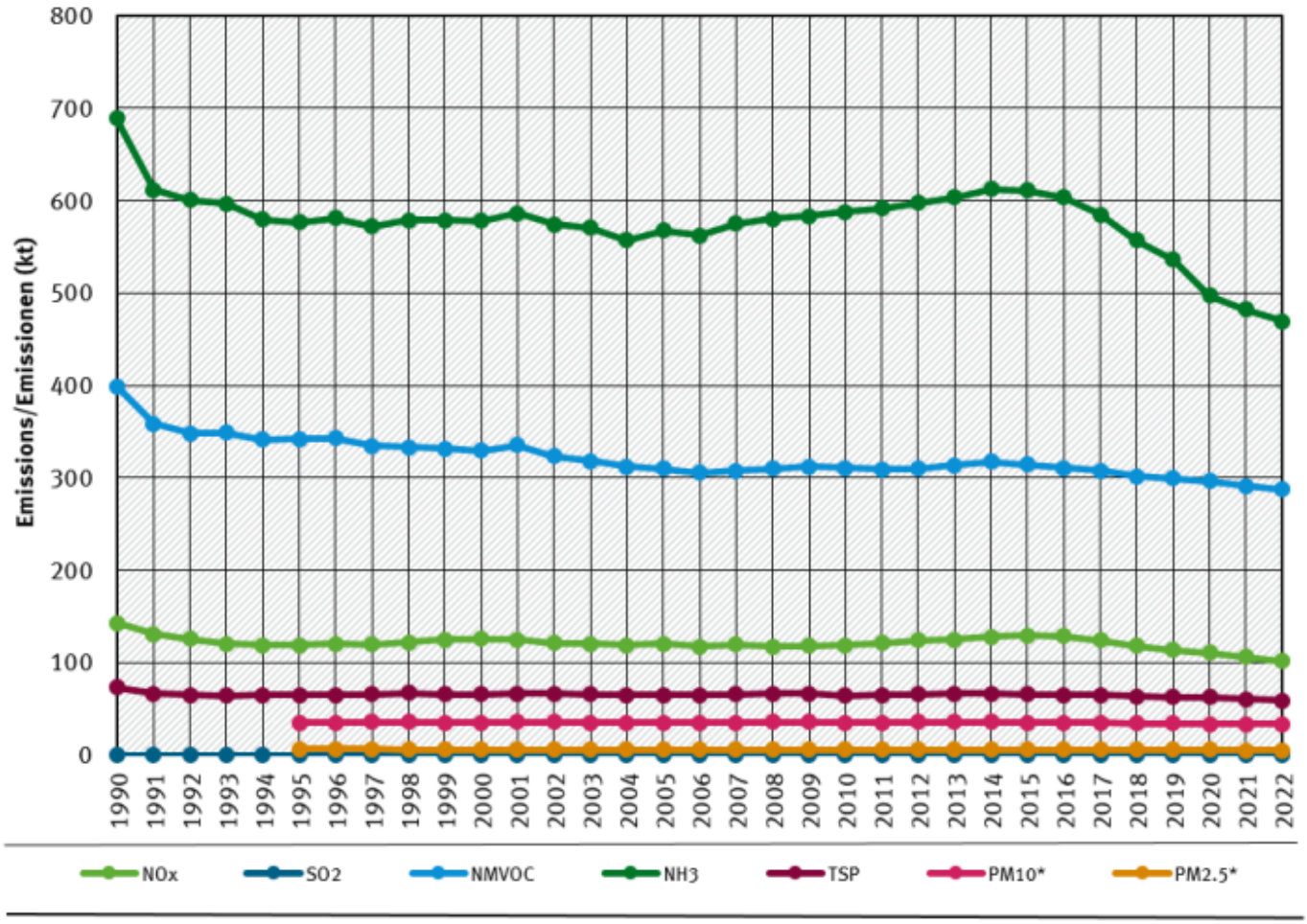
1. New animal categories: In the present submission emissions from rabbits, ostrich, deer and fur-animals are reported for the first time.
2. Imported manure: Emissions from spreading manure that was imported from The Netherlands is reported for the first time in the present submission.
3. Dairy cows: Milk yield and slaughter weights for 2021 have been slightly corrected in the official statistics.
4. Heifers: 2021 slaughter weights have been slightly corrected in the official statistics.
5. Male beef cattle: In some years, slaughter ages and slaughter weights have been updated in the HIT database.
6. Numbers of laying hens, pullets and broilers were corrected in the years before 2013. The numbers are higher than in earlier submissions..
7. Sows: For several federal states, the number of piglets per sow and year was corrected for the year 2021.
8. Fattening pigs: for several federal states the growth rates, start weights and final weights for the year 2021 were corrected. For Saxony and Saxony-Anhalt (no more recent data available than 2016 or 2017) the corresponding data from the neighboring federal state of Thuringia was adopted instead of keeping the last known value as was previously the case.
9. Broilers: Update of the national gross production of broiler meat in 2021.
10. Laying hens and pullets: due to new weight data for laying hens for 2021, the starting and final weights of laying hens have been recalculated for the entire timeseries. Since the initial weight of the laying hens corresponds to the final weight of the pullets, this also has (small) effects on the energy requirements and excretion of the pullets.
11. Application of inorganic fertilizers: The mitigating factor for urea emissions if applied with urease inhibitor (since the year 2020) was reduced from 70 % to 60 %. Correction of amounts applied in some years before 2008 due to a mistake in calculation of the mean value of the three years going into the moving average.
12. Application of sewage sludge: Replacement of extrapolated activity data in 2021 with data from the Federal Statistical Office and corrections of activity data for years after 2006.
13. Anaerobic digestion: Update of activity data in all years due to new data about underlying substrate characteristics and storage data. This applies to both digested energy crops and digested animal manure.

Visual overview

Emission trends for main pollutants in *NFR 3 - Agriculture*:

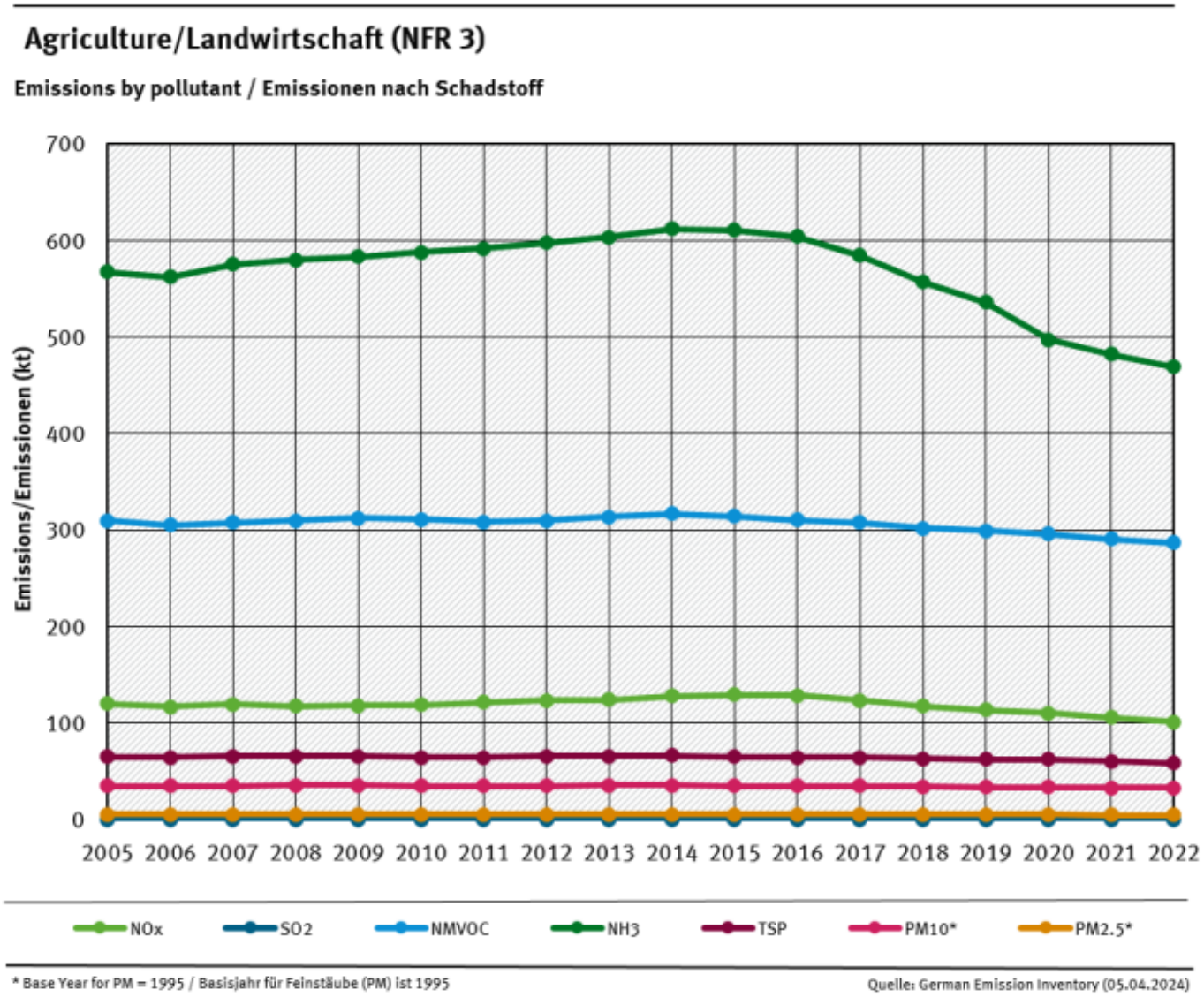
Agriculture/Landwirtschaft (NFR 3)

Emissions by pollutant / Emissionen nach Schadstoff

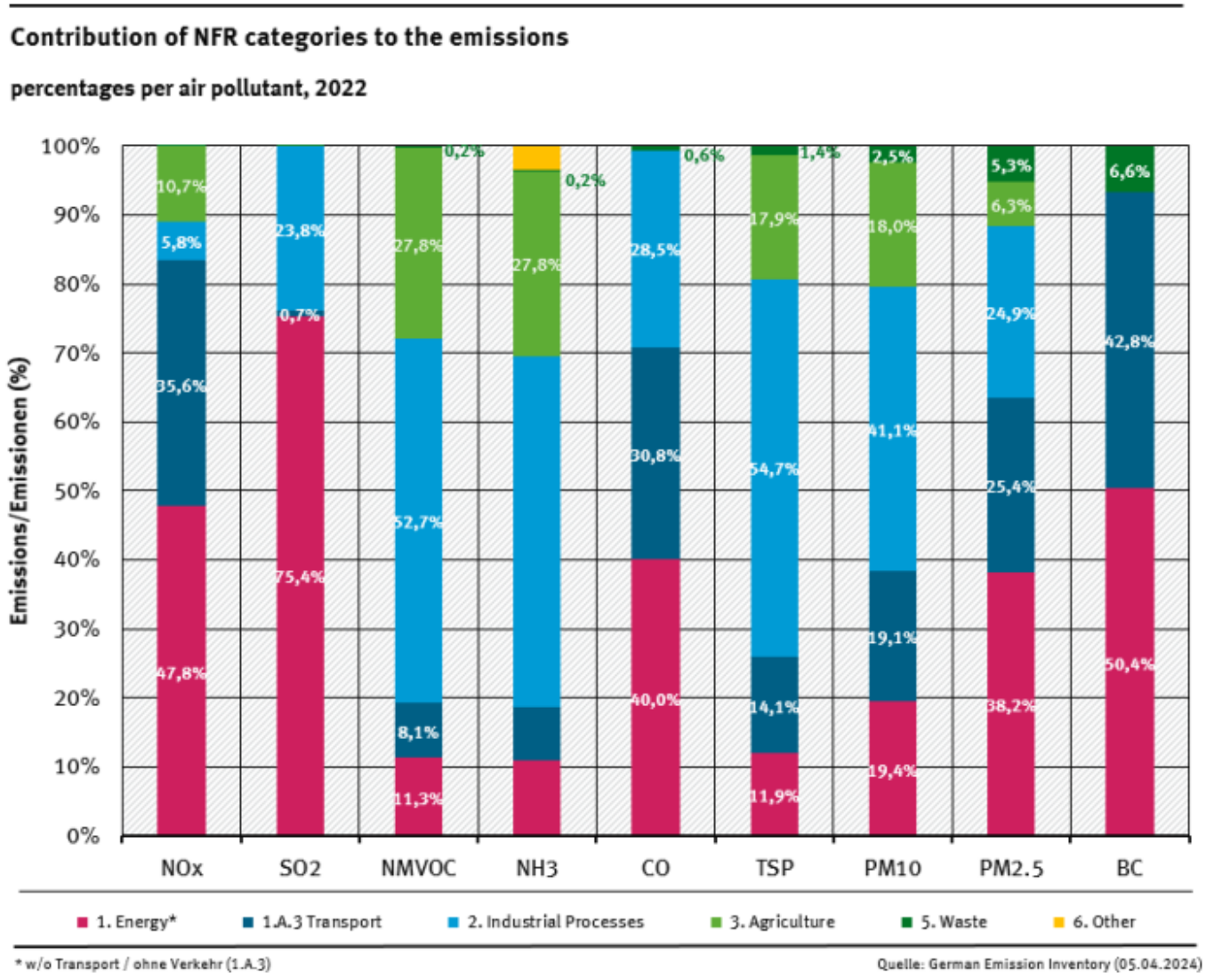


* Base Year for PM = 1995 / Basisjahr für Feinstäube (PM) ist 1995

Quelle: German Emission Inventory (05.04.2024)



[Contribution of NFRs 1 to 6 to the National Totals, for 2021]



Specific QA/QC procedures for the agriculture sector

Numerous input data were checked for errors resulting from erroneous transfer between data sources and the tabular database used for emission calculations. The German IEFs and other data used for the emission calculations were compared with EMEP default values and data of other countries (see Vos et al., 2024). Changes of data and methodologies are documented in detail (see Vos et al. 2024, Chapter 1.3).

A comprehensive review of the emission calculations was carried out by comparisons with the results of Submission 2023 and by plausibility checks.

Once emission calculations with the German inventory model Py-GAS-EM are completed for a specific submission, activity data (AD) and implied emission factors (IEFs) are transferred to the CSE database (Central System of Emissions) to be used to calculate the respective emissions within the CSE. These CSE emission results are then cross-checked with the emission results obtained by Py-GAS-EM.

Furthermore, in addition to UNFCCC, UNECE and NEC reviews, the Py-GAS-EM model is continuously validated by experts of KTBL (Kuratorium für Technik und Bauwesen in der Landwirtschaft, Association for Technology and Structures in Agriculture) and the EAGER group (European Agricultural Gaseous Emissions Inventory Researchers Network).

[1)]

Vos C, Rösemann C, Haenel H-D, Dämmgen U, Döring U, Wulf S, Eurich-Menden B, Freibauer A, Döhler H, Steuer, B, Osterburg B, Fuß R (2024) Calculations of gaseous and particulate emissions from German agriculture 1990 – 2022 : Report on methods and data (RMD) Submission 2024. www.eminv-agriculture.de

[2)]

Bittman, S., Dedina, M., Howard C.M., Oenema, O., Sutton, M.A., (eds) (2014): Options for Ammonia Mitigation. Guidance from the UNECE task Force on Reactive Nitrogen. Centre for Ecology and Hydrology, Edinburgh, UK