# 3.I - Agricultural: Other

## Short description

| NFR-Code | Name of Category | Method | AD | EF |
|---|---|---|---|---|
| 3.I | Agriculture: other | | | |
| *consisting of / including source categories:* | | | | |
| 3.I | Storage of digestate from energy crops | T2 ($NH_3$, $NO_x$) | Q, PS | CS ($NH_3$, $NO_x$) |

| **Method(s) applied** | |
|---|---|
| **D** | Default |
| **T1** | Tier 1 / Simple Methodology * |
| **T2** | Tier 2* |
| **T3** | Tier 3 / Detailed Methodology * |
| **C** | CORINAIR |
| **CS** | Country Specific |
| **M** | Model |
| * as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in category chapters. | |
| **(source for) Activity Data** | |
| **NS** | National Statistics |
| **RS** | Regional Statistics |
| **IS** | International Statistics |
| **PS** | Plant Specific |
| **As** | Associations, business organisations |
| **Q** | specific Questionnaires (or surveys) |
| **M** | Model / Modelled |
| **C** | Confidential |
| **(source for) Emission Factors** | |
| **D** | Default (EMEP Guidebook) |
| **CS** | Country Specific |
| **PS** | Plant Specific |
| **M** | Model / Modelled |
| **C** | Confidential |

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| **$NO_x$** | NMVOC | $SO_2$ | **$NH_3$** | $PM_{2.5}$ | $PM_{10}$ | TSP | BC | CO | Heavy Metals | POPs |
|---|---|---|---|---|---|---|---|---|---|---|
| -/- | NA | NA | -/- | NA | NA | NA | NA | NA | NA | NA |

| | |
|---|---|
| **L/-** | key source by **L**evel only |
| **-/T** | key source by **T**rend only |
| **L/T** | key source by both **L**evel and **T**rend |
| -/- | no key source for this pollutant |
| IE | emission of specific pollutant **I**ncluded **E**lsewhere (i.e. in another category) |
| NE | emission of specific pollutant **N**ot **E**stimated (yet) |
| NA | specific pollutant not emitted from this source or activity = **N**ot **A**pplicable |
| * | no analysis done |

### Country specifics

In 2022, $NH_3$ emissions from category 3.I (agriculture other) reached up to 0.49 % from total agricultural emissions, which is equal to ~ 2.3 kt $NH_3$. $NO_x$ emissions from category 3.I contribute 0.12 % (~ 0.12 kt) to the total agricultural emissions. All these emissions originate from the storage of digestate from energy crops (for details on anaerobic digestion of energy crops see Vos et al. 2024, Chapter 5.1[1)]. The emissions resulting from the application of energy crop digestates as organic fertilizer are dealt with under 3.D.a.2.c.

## Activity Data

Time series of activity data have been provided by KTBL (Kuratorium für Technik und Bauwesen in der Landwirtschaft / Association for Technology and Structures in Agriculture). From these data the amount of N in energy crops fed into anaerobic digestion was calculated.

*Table 1: N amount in energy crops fed into anaerobic digestion*

| N amount in energy crops in Gg N | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1990** | **1995** | **2000** | **2005** | **2010** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
| 0.0 | 0.6 | 5.3 | 45.1 | 163.0 | 293.7 | 292.2 | 287.4 | 283.2 | 283.2 | 289.3 | 283.8 | 283.8 |

*Table 2: Distribution of gastight storage and storage in open tank of energy crop digestates*

| Distribution of gastight storage and non-gastight storage, in % | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1990** | **1995** | **2000** | **2005** | **2010** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
| gastight | 0.0 | 4.7 | 9.4 | 15.8 | 42.2 | 64.0 | 65.6 | 67.1 | 68.7 | 70.2 | 71.8 | 73.3 | 73.3 |
| non-gastight | 100.0 | 95.3 | 90.6 | 84.2 | 57.8 | 36.0 | 34.4 | 32.9 | 31.3 | 29.8 | 28.2 | 26.7 | 26.7 |

## Methodology

The calculation of emissions from storage of digestate from energy crops considers two different types of storage, i.e. gastight storage and open tank. The frequencies of these storage types are also provided by KTBL (see Table 2). There are no emissions of $NH_3$ and NO from gastight storage of digestate. Hence the total emissions from the storage of digestate are calculated by multiplying the amount of N in the digestate leaving the fermenter with the relative frequency of open tanks and the emission factor for open tank. The amount of N in the digestate leaving the fermenter is identical to the N amount in energy crops fed into anaerobic digestion (see Table 1) because N losses from pre-storage are negligible and there are no N losses from fermenter (see Vos et al. 2024, Chapter 5.1).

## Emission factors

As no specific emission factor is known for the storage of digestion residues in open tanks, the $NH_3$ emission factor for storage of cattle slurry with crust in open tanks was adopted (0.045 kg $NH_3$ -N per kg TAN). This choice of emission factor is based on the fact that energy crops are, in general, co-fermented with animal manures (i. e. mostly slurry) and that a natural crust forms on the liquid digestates due to the relatively high dry matter content of the energy crops. The TAN content after the digestion process is 0.56 kg TAN per kg N. The NO emission factor for storage of digestion residues in open tanks was set to 0.0005 kg NO-N per kg N. Table 3 shows the resulting implied emission factors for $NH_3$ -N and NO-N. $NO_x$ emissions are related to NO-N emissions by the ratio of 46/14. This relationship also holds for NO-N and $NO_x$ emission factors.

*Table 3: IEF for $NH_3$ -N and NO-N emissions from storage of digested energy crops*

| **1990** | **1995** | **2000** | **2005** | **2010** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEF in kg $NH_3$-N per kg N in digested energy crops | | | | | | | | | | | | |
| 0.0252 | 0.0240 | 0.0228 | 0.0212 | 0.0146 | 0.0090 | 0.0086 | 0.0083 | 0.0079 | 0.0075 | 0.0071 | 0.0067 | 0.0067 |
| IEF in kg NO-N per kg N in digested energy crops | | | | | | | | | | | | |
| 0.00050 | 0.00048 | 0.00045 | 0.00042 | 0.00029 | 0.00018 | 0.00017 | 0.00016 | 0.00016 | 0.00015 | 0.00014 | 0.00013 | 0.00013 |

## Trend discussion for Key Sources

$NH_3$ and $NO_x$ from storage of anaerobically digested energy crops are no key source.

## Recalculations

All time series of the emission inventory have completely been recalculated since 1990. Table REC-1 shows the effects of recalculations on $NH_3$ and $NO_x$ emissions from storage of anaerobically digested energy crops. Differences to last year's submission occur in all years and are due to the update of activity data (see main page of the agricultural sector, Chapter 5 -

NFR 3 - Agriculture (OVERVIEW), **recalculation No. 13**). For further details on recalculations see Vos et al. (2024), Chapter 1.3.

*Table REC-1: Comparison of $NH_3$ and $NO_x$ emissions of the submissions (SUB) 2023 and 2024*

| NH3 / NOx emissions in Gg | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1990** | **1995** | **2000** | **2005** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
| NH3 | 2023 | 0.0015 | 0.0180 | 0.1482 | 1.1624 | 3.2281 | 3.2124 | 3.0579 | 2.8835 | 2.7108 | 2.5822 | 2.5074 | 2.3137 | 2.3137 |
| NH3 | 2022 | 0.0015 | 0.0190 | 0.1563 | 1.2267 | 3.2814 | 3.3428 | 3.3004 | 3.2741 | 3.2013 | 3.1419 | 3.1782 | 3.1782 | |
| relative change | | 0.00 | 0.00 | -0.01 | -0.06 | -0.05 | -0.13 | -0.24 | -0.39 | -0.49 | -0.56 | -0.67 | -0.86 | |
| absolute change [%] | | -5.19 | -5.19 | -5.19 | -5.24 | -1.62 | -3.90 | -7.35 | -11.93 | -15.32 | -17.81 | -21.11 | -27.20 | |
| NOx | 2023 | 0.0001 | 0.0010 | 0.0080 | 0.0624 | 0.1733 | 0.1725 | 0.1642 | 0.1548 | 0.1455 | 0.1386 | 0.1346 | 0.1242 | 0.1242 |
| NOx | 2022 | 0.0001 | 0.0010 | 0.0084 | 0.0659 | 0.1762 | 0.1795 | 0.1772 | 0.1758 | 0.1719 | 0.1687 | 0.1706 | 0.1706 | |
| relative change | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | -0.01 | -0.02 | -0.03 | -0.03 | -0.04 | -0.05 | |
| absolute change [%] | | -5.19 | -5.19 | -5.19 | -5.24 | -1.62 | -3.90 | -7.35 | -11.93 | -15.32 | -17.81 | -21.11 | -27.20 | |

For **pollutant-specific information on recalculated emission estimates for Base Year and 2021**, please see the tables following chapter 8.1 - Recalculations.

## Uncertainty

Details are described in chapter 1.7.

[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