

3.D - Agricultural Soils

Short description

NFR-Code	Name of Category	Method	AD	EF
3.D	Agricultural Soils			
consisting of / including source categories				
3.D.a.1	Inorganic N-fertilizers (includes also urea application)	T2 (NH ₃), T1 (NO _x)	NS, RS	D (NH ₃), D (NO _x)
3.D.a.2.a	Animal manure applied to soils	T2, T3 (NH ₃), T1 (NO _x)	M	CS (NH ₃), D (NO _x)
3.D.a.2.b	Sewage sludge applied to soils	T1 (NH ₃ , NO _x)	NS, RS	D (NH ₃), D (NO _x)
3.D.a.2.c	Other organic fertilisers applied to soils (including compost)	T2 (NO _x , NH ₃)	M	CS
3.D.a.3	Urine and dung deposited by grazing animals	T1 (NH ₃ , NO _x)	NS, RS	D
3.D.a.4	Crop residues applied to soil	T2 (NH ₃)	NS, RS	D
3.D.c	Farm-level agricultural operations including storage, handling and transport of agricultural products	T2 (TSP, PM ₁₀ , PM _{2.5})	NS, RS	D
3.D.d	Off-farm storage, handling and transport of bulk agricultural products	NA & NR (Black Carbon only)		
3.D.e	Cultivated crops	T2 (NMVOC)	NS, RS	D
3.D.f	Use of pesticides	T2 (HCB)	NS	D
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			

	NO _x	NMVOC	SO ₂	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	B(a)P	B(b)F	B(k)F	I(x)P	PAH1-4	HCB	PCBs
3.D.a.1	L/T	NA	NA	L/T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.a.2.a	L/-	IE	NA	L/T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.a.2.b	-/-	NA	NA	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.a.2.c	-/-	NA	NA	L/T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.a.3	-/-	IE	NA	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.a.4	NA	NA	NA	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.c	NA	NA	NA	NA	L/-	L/-	L/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.e	NA	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.f	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	L/-	NA

L/-	key source by Level only
-/T	key source by Trend only
L/T	key source by both Level and Trend
-/-	no key source for this pollutant
IE	emission of specific pollutant Included Elsewhere (i.e. in another category)
NE	emission of specific pollutant Not Estimated (yet)
NA	specific pollutant not emitted from this source or activity = Not Applicable
*	no analysis done

Country specifics



NH₃ and NO_x

In 2024, agricultural soils emitted 295.1 kt NH₃ or 61.0 % of the total agricultural NH₃ emissions in Germany (484.0 kt NH₃). The main contributions to the total NH₃ emissions from agricultural soils are the application of manure (3.D.a.2.a), with 171.4 kt (58.1 %), the application of other organic N-fertilizers (3.D.a.2.c) with 57.2 kt (19.4 %), and the application of inorganic N-fertilizers (3.D.a.1) with 42.9 kt (14.5 %).

N excretions on pastures (3.D.a.3) have a share of 15.2 kt NH₃ (5.2 %), emissions from crop residues (3.D.a.4) are 7.1 kt NH₃ (2.4 %), and the application of sewage sludge (3.D.a.2.b) 1.4 kt NH₃ (0.5 %).

In 2024, agricultural soils were the source of 98.3 % (96.4 kt) of the total of NO_x emissions in the agricultural category (98.0 kt). The NO_x emissions from agricultural soils are primarily due to application of inorganic fertilizer (3.D.a.1) (40.5 kt) and manure (3.D.a.2.a) (36.1 kt). Application of other organic N-fertilizers (3.D.a.2.c) contributes 14.7 kt, 5.3 kt are due to excretions on pastures (3.D.a.3). Emissions from application of sewage sludge (3.D.a.2.b) contribute 0.4 kt.

NM VOC

In 2024, the category of agricultural soils contributed 8.9 kt NM VOC or 2.9 % to the total agricultural NM VOC emissions in Germany (300.6 kt NM VOC). The only emission source was cultivated crops (3.D.e).

TSP, PM₁₀ & PM_{2.5}

In 2024, agricultural soils contributed, respectively, 38.4 % (23.2 kt), 66.7 % (23.2 kt) and 33.6 % (1.8 kt) to the total agricultural TSP, PM₁₀ and PM_{2.5} emissions (60.4 kt, 34.7 kt, 5.3 kt, respectively). The emissions are reported in category 3.D.c (Farm-level agricultural operations including storage, handling and transport of agricultural products).

3.D.a.1 - Inorganic N-fertilizers

The calculation of NH₃ and NO_x (NO) emissions from the application of synthetic fertilizers is described in Vos et al. (2026)¹⁾, Chapters 5.2.1.2 and 5.2.2.2 1).

Activity Data

German statistics report the amounts of fertilizers sold which are assumed to equal the amounts that are applied. Since the 2021 submission, storage effects are approximated by applying a moving average to the sales data (moving centered three-year average, for the last year a weighted two-year average, which assigns 2/3 of the weight to the last year). Since the year 2022, data for the sales of urea that is stabilized with urease inhibitor is available. It cannot be published because of data-privacy issues. Therefore, the emissions are calculated and provided by the federal statistical office using the emission factors as described below. The activity data are published in aggregate for urea, urea+inhibitor and nitrogen solutions to maintain confidentiality. For details see Vos et al. (2026), Chapter 2.8.

Table 1: AD for the estimation of NH₃ and NO_x emissions from application of synthetic fertilizers

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Application of fertilizers (total)	2,195	1,723	1,922	1,797	1,635	1,736	1,731	1,622	1,499	1,404	1,327	1,245	1,123	1,048	1,028
calcium ammonium nitrate	1,368	1,044	982	824	689	618	605	571	543	520	497	470	422	396	388
urea and ammonia nitrate urea solutions (AHL)	369	403	508	526	542	590	604	539	460	385	342	318	293	276	262
ammonium phosphates	85	55	66	55	64	84	82	77	65	64	58	51	41	36	38
other NK and NPK	246	162	175	126	63	67	62	54	52	51	51	47	40	34	31
other straight fertilizers	127	60	191	266	277	377	377	381	378	383	379	359	328	306	309

Methodology

NH₃ emissions from the application of synthetic fertilizers are calculated using the Tier 2 approach according to EMEP (2023)-3D-16ff²⁾, distinguishing between various fertilizer types, see Table 2. For NO_x, the Tier 1 approach described in EMEP (2023) [10]-3D-15 is applied.

Emission factors

The emission factors for NH₃ depend on fertilizer type, see EMEP (2023)-3D-17. Table 2 lists the EMEP emission factors for the fertilizers used in the inventory. In order to reflect average German conditions, the emission factors for cool climate and a pH value lower than 7 was chosen. For urea fertilizer the German fertilizer ordinance prescribes the use of urease inhibitors or the immediate incorporation into the soil from 2020 onwards. The NH₃ emission factor for urea fertilizers is therefore reduced by 70% from 2020 onwards for the immediate incorporation of urea, according to Bittman et al. (2014, Table 15)³⁾. For the use of urease inhibitors the emission factor for urea fertilizer is reduced by 60%. For details see Vos et al. (2026), Chapter 5.2.1.2.

Table 2: Synthetic fertilizers, emission factors in kg NH₃ per kg fertilizer N

Fertilizer type	EF
calcium ammonium nitrate	0.024
ammonia nitrate urea solutions (AHL)	0.087
urea (up to 2019)	0.195
urea (from 2020 with urease inhibitor)	0.078
urea (from 2020 if incorporated)	0.0585
ammonium phosphates	0.084
other NK and NPK	0.084
other straight fertilizers	0.024

For NO_x, the simpler methodology by EMEP (2023)-3D-13 was used. The emission factor 0.040 from EMEP, 2023-3D, Table 3.1 has the unit of [kg N₂O per kg fertilizer N] and was derived from Stehfest and Bouwman (2006)⁴.

The German inventory uses the emission factor 0.012 kg NO-N per kg N derived from Stehfest and Bouwman (2006) directly. This is equivalent to an emission factor of 0.03943 kg NO_x per kg fertilizer N (obtained by multiplying 0.012 kg NO-N per kg N with the molar weight ratio 46/14 for NO₂: NO). The inventory uses the unrounded emission factor.

Table 3: Emission factor for NO_x emissions from fertilizer application

Emission factor	kg NO-N per kg fertilizer N	kg NO _x per kg fertilizer N
EF _{fert}	0.012	0.039

Trend discussion for Key Sources

Since 2016, fertilizer sales have fallen dramatically (by around a third). Emissions have fallen accordingly. This is even more pronounced for NH₃ than for NO_x, as total NH₃ from the application of mineral fertilizers is, until the year 2019, very strongly correlated with the amount of urea applied ($R^2 = 0.64$), the sales of which have decreased more than for all other mineral fertilizers. Since 2020 the negative trend is reinforced as urea fertilizer has to be either used with urease inhibitors or has to be incorporated into the soil directly, which reduces emissions.

Recalculations

Table 4 shows the effects of recalculations on NH₃ and NO_x emissions. The big differences for NH₃ emissions are due to the correction of the EMEP (2023) emission factor for straight fertilizers (**recalculation No. 2**). Concerning NO_x emissions differences only occur in 2023, resulting from applying the moving average to sales data (see activity data).

Table 4: Comparison of NH₃ and NO_x emissions [kt] with previous submission

		NH ₃ and NO _x emissions from inorganic fertilizer application, in kt														
	Submission	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Ammonia	current	121.93	99.21	119.19	118.44	120.16	133.00	135.03	121.47	105.50	91.66	54.81	52.05	47.52	44.08	42.89
	previous	129.55	102.80	130.65	134.39	136.77	155.61	157.68	144.31	128.19	114.66	77.56	73.59	67.18	61.79	
	absolute change	-7.61	-3.59	-11.46	-15.96	-16.61	-22.61	-22.65	-22.84	-22.69	-23.01	-22.75	-21.54	-19.66	-17.71	
	relative change [%]	-5.88	-3.49	-8.77	-11.87	-12.14	-14.53	-14.36	-15.83	-17.70	-20.06	-29.33	-29.27	-29.27	-28.67	
Nitrogen oxides	current	86.53	67.93	75.77	70.84	64.48	68.46	68.24	63.95	59.11	55.34	52.31	49.08	44.29	41.31	40.55
	previous	86.53	67.93	75.77	70.84	64.48	68.46	68.24	63.95	59.11	55.34	52.31	49.08	44.29	40.89	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	

Planned improvements

No improvements are planned at present.

3.D.a.2.a - Animal manure applied to soils

In this sub-category Germany reports the NH₃ and NO_x (NO) emissions from application of manure (including application of anaerobically digested manure). An overview is given in Vos et al. (2026), Chapters 5.2.1.2 and 5.2.2.2.

Germany uses the Tier 2 methodology for estimating NMVOC emissions for cattle in sector 3.B (manure management). The use of this methodology yields NMVOC emissions which formally could be reported in the sectors 3.D.a.2.a and 3.D.a.3 (grazing emissions). However, to be congruent with the NMVOC emissions for other animal categories, Germany reports these emissions in the NMVOC emissions reported from manure management (3.B). For the NFR codes 3.D.a.2.a and 3.D.a.3 the notation key IE is used for NMVOC emissions.

Activity data

The calculation of the amount of N in manure applied is based on the N mass flow approach (see 3.B). It is the total of N excreted by animals in the housing and the N imported with bedding material minus N losses by emissions of N species from housing and storage. Hence, the amount of total N includes the N contained in anaerobically digested manures to be applied to the field.

The frequencies of application techniques and incorporation times as well as the underlying data sources are described in Vos et al. (2026), Chapter 2.5. The frequencies are provided in the NID 2026⁵⁾, Chapter 17.3.1.

Table 5: AD for the estimation of NH₃ and NO_x emissions from application of manure

Application of manure in kt N														
1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1,236	1,088	1,047	1,009	996	1,036	1,032	1,036	1,020	1,007	987	953	927	924	915

Methodology

NH₃ emissions from manure application are calculated separately for each animal species in the mass flow approach by multiplying the respective TAN amount with NH₃ emission factors for the various manure application techniques. For details see [3-b-manure-management 3.B] and Vos et al. (2026), Chapter 5.2.1.2. For NO_x emissions from manure application the inventory calculates NO-N emissions (see Vos et al. (2026), Chapter 5.2.2.2, that are subsequently converted into NO_x emissions by multiplying with the molar weight ratio 46/14. The Tier 1 approach as described in EMEP (2023)-3D-13 is used.

Emission factors

The following table shows the time series of the overall German NH₃ IEF defined as the ratio of total NH₃-N emission from manure application to the total amount of N spread with manure. For NO_x the same emission factor like for the application of synthetic fertilizer was used (see Table 3).

Table 6: IEF for NH₃-N from application of manure

IEF in kg NH ₃ -N per kg N in applied manure														
1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
0.216	0.204	0.196	0.183	0.175	0.165	0.163	0.162	0.159	0.157	0.154	0.154	0.157	0.155	0.154

Trend discussion for Key Sources

Both NH₃ and NO_x emissions from the application of animal manure are key sources. Total NO_x is calculated proportionally to the total N applied with manure which decreased remarkably from 1990 to 1991 due to the decline in animal numbers following the German reunification (reduction of livestock numbers in Eastern Germany). In the 1990s and 2000s this was followed by a weakened decline in animal manure amounts. From 2010 to 2014 there was a slight increase and since then the amount of N in manure applied has been declining again, see Table 5. The NO_x emissions follow these trends. For total NH₃ emissions there is a negative trend. This is due to the decreasing amounts of animal manure and the increasing use of application practices with lower NH₃ emission factors.

Recalculations

Until 2000, the total emissions of NH₃ from application of manure are higher than those of last year's submission and thereafter they are lower. For NO_x the changes are similar, however the change from higher to lower values takes place 20 years later.

These differences are predominantly caused by different estimates of manure N, which is applied, compared to the last submission. Many of the recalculations have an effect on this, especially the **recalculations No. 2, No. 3, No. 4, No. 5, and No. 6**. The two most important ones are **No. 3** (the new methodology to calculate N and TAN excretions of dairy cows leads to higher N excretion at the beginning and lower N excretions at the end of the time series, the percentage shares of TAN are lower for all years. The latter is responsible for the earlier change in the trend of NH₃ emissions) and **No. 4** (higher

milk yields generally increase excretions), see [main page of the agricultural sector](#), list of recalculation reasons. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 7: Comparison of NH₃ and NO_x emissions [kt] with previous submission

		NH ₃ and NO _x emissions from application of manure, in kt														
	Submission	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Ammonia	current	324.37	268.83	249.29	224.08	211.68	207.35	204.72	203.36	197.44	192.54	184.02	178.16	176.66	174.47	171.37
	previous	320.57	265.78	249.01	225.69	217.80	215.60	211.87	208.09	202.39	197.93	192.18	188.44	185.70	185.00	
	absolute change	3.79	3.05	0.28	-1.61	-6.12	-8.26	-7.15	-4.73	-4.95	-5.39	-8.17	-10.28	-9.04	-10.52	
	relative change [%]	1.18	1.15	0.11	-0.71	-2.81	-3.83	-3.38	-2.27	-2.45	-2.72	-4.25	-5.45	-4.87	-5.69	
Nitrogen oxides	current	48.75	42.89	41.29	39.77	39.27	40.85	40.69	40.83	40.20	39.72	38.91	37.56	36.55	36.44	36.08
	previous	45.94	40.69	39.69	38.54	38.63	40.23	39.98	39.81	39.26	38.98	38.66	37.68	36.65	36.65	
	absolute change	2.81	2.20	1.60	1.23	0.64	0.62	0.71	1.02	0.94	0.74	0.26	-0.13	-0.10	-0.21	
	relative change [%]	6.11	5.42	4.04	3.19	1.65	1.55	1.77	2.57	2.40	1.90	0.67	-0.34	-0.27	-0.58	

Planned improvements

No improvements are planned at present.

3.D.a.2.b - Sewage sludge applied to soils

The calculation of NH₃ and NO_x (NO) emissions from application of sewage sludge is described in Vos et al. (2026), Chapters 5.2.1.2 and 5.2.2.2.

Activity data

N quantities from application of sewage sludge were calculated from data of the German Environment Agency and (since 2009) from data of the Federal Statistical Office.

Table 8: AD for the estimation of NH₃ and NO_x emissions from application of sewage sludge

Application of sewage sludge in kt N														
1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
27	35	33	27	26	19	19	14	13	16	14	12	12	10	10

Methodology

A Tier 1 methodology is used (EMEP, 2023, 3D, Chapter 3.3.1). NH₃ and NO_x emissions are calculated by multiplying the amounts of N in sewage sludge applied with the respective emission factors.

Emission factors

EMEP (2023)-3.D, Table 3-1 provides a Tier 1 emission factor for NH₃ (0.13 kg NH₃ per kg N applied) emissions from application of sewage sludge. The German inventory uses the equivalent emission factor in NH₃-N units which is 0.11 kg NH₃-N per kg N applied (cf. the derivation of the emission factor described in the appendix of EMEP (2023)-3D, page 35). For NO_x the same emission factor like for the application of synthetic fertilizer was used (see Table 3).

Trend discussion for Key Sources

NH₃ and NO_x emissions from the application of sewage sludge are no key sources.

Recalculations

There were no recalculations concerning sewage sludge except the replacement of extrapolated activity data in 2023 with data from the Federal Statistical Office. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 9: Comparison of NH₃ and NO_x emissions [kt] with previous submission

		NH ₃ and NO _x emissions from application of sewage sludge, in kt														
	Submission	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Ammonia	current	3.66	4.71	4.40	3.66	3.51	2.52	2.51	1.87	1.78	2.14	1.85	1.61	1.61	1.39	1.39
	previous	3.66	4.71	4.40	3.66	3.51	2.52	2.51	1.87	1.78	2.14	1.85	1.61	1.61	1.61	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.22	
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-13.84	
Nitrogen oxides	current	1.08	1.39	1.30	1.08	1.04	0.74	0.74	0.55	0.52	0.63	0.55	0.47	0.48	0.41	0.41
	previous	1.08	1.39	1.30	1.08	1.04	0.74	0.74	0.55	0.52	0.63	0.55	0.47	0.48	0.48	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07	
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-13.84	

Planned improvements

No improvements are planned at present.

3.D.a.2.c - Other organic fertilizers applied to soils

This sub category contains the total of Germany's NH₃ and NO_x (NO) emissions from application of

- residues from digested energy crops,
- residues from digested waste,
- compost from biowaste,
- compost from green waste, and
- imported animal manures.

For details see Vos et al. (2026), Chapters 5.2.1.2 and 5.2.2.2.

Activity data

Activity data is the amount of N in residues from anaerobic digestion of energy crops and waste and of compost from biowaste and green waste when leaving storage, as well as the amount of N in imported animal manures. For energy crops this is the N contained in the energy crops when being fed into the digestion process minus the N losses by emissions of N species from the storage of the residues (see 3.1). N losses from pre-storage are negligible and there are no N losses from fermenter (see Vos et al. (2026), Chapter 5.1). For residues from digested waste, compost from biowaste and compost from green waste the amount of N was derived from the waste statistics of the Federal Statistical Office (see Vos et al. (2026), Chapter 2.8). For imported manure the amounts of N were derived from statistics published by CBS (Statistics Netherlands) and RVO (Rijksdienst voor Ondernemend Nederland) The imported manure is categorized into cattle slurry, pig slurry, poultry manure, horse manure and mixed solid manure. Only imported manures from The Netherlands are taken into account, as for other countries the amounts of imported manures are unknown as are the amounts of exported manure. For details see Vos et al. (2026), Chapter 2.8.

Table 10: AD for the estimation of NH₃ and NO_x emissions from application of other organic fertilizers

		Application of other organic fertilizers in kt N														
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Residues, digested energy crops	0.05	0.59	5.12	43.36	158.69	289.08	287.80	283.33	279.45	279.98	286.48	281.57	302.37	293.35	293.35	

Residues, digested waste	0.00	0.00	1.55	4.97	10.46	15.05	13.97	13.79	14.00	13.75	13.40	15.13	15.62	17.49	18.20
Compost, biowaste	4.51	19.54	31.87	28.82	22.64	22.59	23.34	21.90	25.14	24.31	25.42	22.98	23.10	19.90	18.53
Compost, greenwaste	1.13	4.90	7.67	9.46	11.27	13.67	14.29	14.87	14.92	15.89	16.74	15.95	15.93	14.62	13.85
Imported manure	5.19	19.26	15.56	21.48	28.15	28.75	30.26	27.52	22.17	21.27	18.14	15.32	14.24	16.59	16.51
TOTAL	10.87	44.30	61.77	108.09	231.21	369.15	369.65	361.40	355.67	355.21	360.19	350.95	371.26	361.95	360.44

Methodology

The NH₃ emissions are calculated the same way as the NH₃ emissions from application of animal manure (3.D.a.2.a). The frequencies of application techniques and incorporation times as well as the underlying data sources are provided e. g. in the NID 2025, Chapter 17.3.1. It is assumed that residues of digested waste are applied in the same way and have the same emission factors as residues from digested energy crops. For compost from biowaste and green waste it is assumed that they are applied in the same way and have the same emission factors as cattle solid manure. The amounts of TAN in the residues from digested energy crops applied are obtained from the calculations of emissions from the storage of the digested energy crops (3.l). The amounts of TAN in the residues from digested waste, compost from biowaste and compost from green waste are derived from industry data (provided by Bundesgütegemeinschaft Kompost, BGK). For the imported manures it is assumed that the different imported manure types (see above) were applied in the same way as the corresponding domestic animal manure types. Mixed manure was treated like solid manure from goats, sheep and horses. Corresponding TAN contents were derived from publications of the German federal states. As published TAN contents vary strongly, for each imported manure type the maximum of published TAN contents was assumed to prevent an underestimation of the NH₃ emissions. For details see Vos et al. (2026), Chapter 2.8.

For NO_x emissions the Tier 1 approach as described in EMEP (2023)-3D-13 is used. The inventory calculates NO emissions that are subsequently converted into NO_x emissions by multiplying with the molar weight ratio 46/30.

Emission factors

For NH₃ the emission factors for untreated cattle slurry were adopted for residues from digested energy crops and residues from waste. The emission factors for cattle solid manure were adopted for compost from biowaste and compost from green waste, see Vos et al. (2026), Chapters 5.2.1.2 and 5.2.2.2. For imported manures the corresponding emission factors of the same type of domestic manure were used.

For NO_x the same emission factor like for the application of synthetic fertilizer was used (see Table 3).

Table 11: IEF for NH₃-N emissions from application of other organic fertilizers

IEF in kg NH ₃ -N per kg N of other organic fertilizers															
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Residues, digested energy crops	0.182	0.185	0.184	0.184	0.186	0.154	0.152	0.149	0.145	0.142	0.139	0.140	0.140	0.140	0.140
Residues, digested waste	0.000	0.000	0.192	0.193	0.193	0.171	0.164	0.156	0.163	0.162	0.163	0.162	0.160	0.157	0.159
Compost, biowaste	0.042	0.037	0.038	0.036	0.034	0.032	0.032	0.032	0.029	0.033	0.034	0.036	0.037	0.033	0.031
Compost, greenwaste	0.016	0.014	0.014	0.014	0.013	0.015	0.015	0.020	0.013	0.012	0.012	0.012	0.013	0.012	0.011
Imported manure	0.209	0.206	0.202	0.186	0.173	0.150	0.145	0.145	0.151	0.149	0.145	0.144	0.145	0.151	0.149
TOTAL	0.120	0.110	0.092	0.131	0.161	0.142	0.139	0.137	0.132	0.130	0.127	0.128	0.130	0.130	0.131

Trend discussion for Key Sources

The application of other organic fertilizers is a key source for NH₃. Emissions are dominated by the emissions from digested energy crops. They have become important since about 2005 and have risen sharply until 2013. Since then, they have changed little each year and tend to decrease slightly in the last few years. The latter is mostly due to the increasing use of

Methodology

NH₃ emissions from grazing are calculated by multiplying the respective animal population (3.B, Table 1) with corresponding N excretions and relative TAN contents (3.B, Table 2) and the fraction of N excreted on pasture (Table 13). The result is multiplied with the animal specific emission factor (Table 14). NO emissions are calculated the same way with the exception that the emission factor is related to N excreted instead of TAN.

Emission Factors

The emission factors for NH₃ are taken from EMEP (2023)-3B-29, Table 3.9. They relate to the amount of TAN excreted on pasture. For laying hens, deer and ostriches there are no emission factors given in this table. Germany uses for laying hens an emission factor of 0.35 kg NH₃-N per kg TAN excreted, based on an expert judgement from KTBL (see Vos et al. 2026, Chapter 5.2.1.1). The same EF is used by UK. It was also used for ostriches. For deer the emission factor of sheep was adopted.

Following the intention of EMEP, 2023-3D, Table 3.1, the inventory uses for NO_x the same emission factor as for the application of synthetic fertilizer (see Table 3). In order to obtain NO_x emissions (as NO₂) the NO-N emission factor of 0.12 kg NO-N per kg N excreted is multiplied by 46/14.

Table 14: Emission factors for emissions of NH₃ and NO from grazing

Dairy cows	0.14 kg NH ₃ -N per kg TAN excreted
Other cattle	0.14 kg NH ₃ -N per kg TAN excreted
Horses	0.35 kg NH ₃ -N per kg TAN excreted
Sheep, goats	0.09 kg NH ₃ -N per kg TAN excreted
Laying hens	0.35 kg NH ₃ -N per kg TAN excreted
Deer	0.09 kg NH ₃ -N per kg TAN excreted
Ostriches	0.35 kg NH ₃ -N per kg TAN excreted
All animals	0.012 kg NO-N per kg N excreted

Trend discussion for Key Sources

Emissions from urine and dung deposited by grazing animals are no key sources.

Recalculations

Until 2012, NH₃ grazing emissions are lower than those of last year's submission and thereafter they are higher. For NO_x emissions from grazing in all years are higher than those of last year's submission. **Recalculations No. 3** (new methodology to calculate N and TAN excretions of dairy cows) and **No. 4** (higher milk yields) lead in combination to higher N excretion of dairy cows, especially at the beginning of the time series, but to lower TAN excretions for all years. Since NH₃ emissions are related to TAN excretion and NO_x emissions are related to N excretion, this leads to lower NH₃ and higher NO emissions. **Recalculation No. 6** (higher N (and TAN) excretion for heavy horses as of 2011) is the reason why, after 2012, NH₃ emissions are higher compared with last year's submission. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 15: Comparison of NH₃ and NO_x emissions [kt] with previous submission

		NH₃ and NO_x emissions from grazing, in kt														
	Submission	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Ammonia	current	24.50	20.91	18.53	16.75	15.95	15.98	15.85	15.83	15.67	15.55	15.33	15.12	15.20	15.35	15.20
	previous	24.58	21.15	18.79	17.00	16.26	15.94	15.73	15.56	15.33	15.19	15.00	14.85	14.93	15.09	
	absolute change	-0.08	-0.24	-0.26	-0.25	-0.31	0.04	0.11	0.27	0.34	0.36	0.33	0.26	0.27	0.25	
	relative change [%]	-0.32	-1.15	-1.38	-1.47	-1.90	0.22	0.71	1.76	2.22	2.36	2.22	1.78	1.84	1.68	

Nitrogen oxides	current	9.44	7.67	6.83	6.12	5.78	5.63	5.56	5.53	5.43	5.35	5.25	5.15	5.15	5.19	5.12
	previous	8.84	7.38	6.66	6.00	5.72	5.55	5.47	5.40	5.30	5.24	5.17	5.11	5.11	5.17	
	absolute change	0.59	0.29	0.17	0.13	0.06	0.07	0.08	0.13	0.13	0.11	0.08	0.04	0.04	0.03	
	relative change [%]	6.73	3.93	2.58	2.09	1.00	1.31	1.55	2.35	2.38	2.05	1.46	0.80	0.70	0.52	

Planned improvements

No improvements are planned at present.

3.D.a.4 - Crop residues applied to soil

The calculation of NH₃ from crop residues is described in Vos et al. (2026), Chapter 5.2.1.3. According to EMEP (2023) NH₃ emissions are only occurring in a significant amount from crop residues on the soil surface, which are present more than three days and have an N content of more than 0.0132 kg N per kg dry matter. This means that there are no NH₃ emissions from most crop residues of the most commonly used crops in Germany. The major source of the emissions are residues of grassland cuts.

Activity data

The NH₃ emissions are calculated proportionally to the amounts of N stored in the above-ground biomass, according to EMEP (2023). This requires the knowledge of the areas of cultivation, of crop yields and of the N contents of the above ground crop residues.

Table 16: AD for the estimation of NH₃ emissions from crop residues

N in aboveground crop residues in kt N														
1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
370	377	418	429	411	417	416	443	348	391	403	425	413	424	424

Methodology

According to EMEP (2023) the NH₃ emissions from crop residues can be neglected when the crop residues are on the field for less than three days. Thus the first step in the emission calculation is determining which share of the crop residues of each crop are incorporated into the soil or removed in the first three days after harvesting the crop. The remaining amounts are multiplied with their respective N contents and the resulting amounts of N are then multiplied with the NH₃-emission factor.

Emission factors

According to the methodology given in EMEP (2023) the emission factor for the NH₃ emissions from crop residues applied to the soil is zero if the N content of the above ground crop residues is below or equal to the threshold of 0.0132 kg N per kg dry matter. In all other cases the NH₃ emission factor is determined using the following linear regression, see EMEP (2023):

$$EF(NH_{3x}) = \frac{(410 \times N_{above\ dm_x} - 5.42)}{100}$$

Where x is the according crop and N_{above dm} is the N content of the above ground dry matter. The implied emission factors provided in the following table are defined as ratio of the total NH₃-N emissions from crop residues to the total N in aboveground crop residues.

Table 17: IEF for NH₃-N emissions from crop residues

IEF in kg NH₃-N per kg N in aboveground crop residues

1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
0.019	0.016	0.014	0.014	0.013	0.013	0.014	0.013	0.013	0.013	0.013	0.014	0.013	0.013	0.014

Trend discussion for Key Sources

NH₃ emissions from crop residues are no key source.

Recalculations

For all years, NH₃ emissions from crop residues are slightly higher than those of last year's submission. The main reason for this is **recalculation No. 15** (update of number of grassland cuts). Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 18: Comparison of NH₃ emissions [kt] with previous submission

		NH ₃ emissions from crop residues, in kt														
	Submission	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Ammonia	current	8.73	7.34	7.17	7.08	6.58	6.45	6.98	7.13	5.50	6.32	6.59	7.38	6.67	6.94	7.06
	previous	8.70	7.32	7.14	7.06	6.55	6.43	6.95	7.11	5.47	6.27	6.51	7.35	6.62	6.89	
	absolute change	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.04	0.05	0.08	0.03	0.05	0.05	
	relative change [%]	0.34	0.35	0.35	0.36	0.40	0.39	0.39	0.39	0.39	0.68	0.75	1.18	0.47	0.76	0.75

Planned improvements

No improvements are planned at present.

3.D.c - Farm-level agricultural operations including storage, handling and transport of agricultural products

In this category Germany reports TSP, PM₁₀ and PM_{2.5} emissions from crop production according to EMEP (2023)-3D-22. For details see Vos et al. (2026), Chapter 5.2.4.

Activity data

The activity data is the total area of agricultural land (arable land, grassland and horticultural land) including areas with cover crops. This data is provided by official statistics.

Table 19: Agricultural land (including areas with cover crops), in [1000*ha]

1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
17,542	16,285	16,457	16,555	17,010	17,447	17,484	17,532	17,509	17,559	17,498	17,431	17,386	17,367	17,142

Methodology

The Tier 2 methodology used is described in EMEP (2023)-3D-22.

Emission factors

Emission factors given in EMEP (2023)-3D-18, Tables 3.6 and 3.8 are used with the exception of „Harvesting“ PM₁₀-factors for Wheat, Rye, Barley and Oat which were taken from the Danish IIR. These Guidebook-EFs are obviously too high by a factor of 10 and were corrected in the Danish IIR.

The missing default-EFs for „other arable“ in the 2023 EMEP/EEA Guidebook were replaced with the average of the EFs of

wheat, rye, barley and oat, as it was done in the Danish IIR. The PM₁₀ EFs were also used as TSP EFs. The Guidebook does not indicate whether EFs have considered the condensable component (with or without). For details on country specific numbers of agricultural crop operations see Vos et al. (2026), Chapter 5.2.4.

Table 20: Implied emission factors for PM emissions from agricultural soils, in kg ha⁻¹

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
TSP	1.42	1.41	1.42	1.41	1.39	1.38	1.37	1.37	1.37	1.36	1.36	1.36	1.36	1.36	1.35
PM₁₀	1.42	1.41	1.42	1.41	1.39	1.38	1.37	1.37	1.37	1.36	1.36	1.36	1.36	1.36	1.35
PM_{2.5}	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.11	0.10

Trend discussion for Key Sources

TSP and PM₁₀ are key sources. Emissions depend on the areas covered, crop types and number of crop operations. With the exception of the numbers of soil cultivations, which is slightly decreasing, these data are relatively constant. Overall this is reflected in a slight decline of emissions in the last years.

Recalculations

There were no recalculations. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 21: Comparison of particle emissions (TSP, PM₁₀ & PM_{2.5}) [kt] with previous submission

		TSP, PM₁₀, PM_{2.5} emissions from crop production, in Gg														
		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
TSP	current submission	24.88	22.99	23.38	23.27	23.64	24.06	24.03	24.07	23.92	23.94	23.73	23.70	23.71	23.69	23.16
	previous submission	24.88	22.99	23.38	23.27	23.64	24.06	24.03	24.07	23.92	23.94	23.73	23.70	23.71	23.69	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM₁₀	current submission	24.88	22.99	23.38	23.27	23.64	24.06	24.03	24.07	23.92	23.94	23.73	23.70	23.71	23.69	23.16
	previous submission	24.88	22.99	23.38	23.27	23.64	24.06	24.03	24.07	23.92	23.94	23.73	23.70	23.71	23.69	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM_{2.5}	current submission	1.90	1.78	1.85	1.85	1.87	1.88	1.87	1.87	1.85	1.84	1.81	1.81	1.82	1.82	1.77
	previous submission	1.90	1.78	1.85	1.85	1.87	1.88	1.87	1.87	1.85	1.84	1.81	1.81	1.82	1.82	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Planned improvements

No improvements are planned at present.

3.D.e - Cultivated crops

In this category Germany reports NMVOC emissions from crop production according to EMEP (2023)-3D-21. For details see Vos et al. (2026), Chapter 5.2.3.

Activity data

The *total area of arable land and grassland* applied as activity data is provided by official statistics.

Table 22: Arable land and grassland, in [1000 ha]

1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
16,506	15,312	15,498	15,561	15,734	15,719	15,662	15,647	15,570	15,563	15,447	15,376	15,336	15,322	15,093

Methodology

The Tier 2 methodology described in EMEP (2023)-3D-21ff is used.

Emission Factors

The emission factors for wheat, rye, rape and grass (15°C) given in EMEP (2023)-3D-21, Table 3.4 were used. For all grassland areas the grass (15°C) EF is used, for all other crops except rye and rape the EF of wheat is used.

The implied emission factors provided in the following table are defined as ratio of the total NMVOC emissions from cultivated crops to the total area given by activity data.

Table 23: IEF for NMVOC emissions from crop production, in [kg ha⁻¹]

1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
0.47	0.53	0.57	0.59	0.61	0.63	0.62	0.62	0.50	0.55	0.59	0.61	0.58	0.60	0.59

Trend discussion for Key Sources

NMVOC emissions from crop production are no key source.

Recalculations

There were no recalculations. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 24: Comparison of NMVOC emissions [kt] with previous submission

	Submission	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
NMVOC	current	7.69	8.19	8.79	9.17	9.53	9.91	9.69	9.74	7.82	8.56	9.16	9.44	8.91	9.23	8.87
	previous	7.69	8.19	8.79	9.17	9.53	9.91	9.69	9.74	7.82	8.56	9.16	9.44	8.91	9.23	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	relative change [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	



For **pollutant-specific information on recalculated emission estimates for Base Year and 2023**, please see the pollutant specific recalculation tables following [chapter 9.1 - Recalculations](#).

Planned improvements



At the moment, no category-specific improvements are planned.

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., Döhler, H., Steuer, B., Osterburg, B., Fuß, R. (2026) Calculations of gaseous and particulate emissions from German agriculture 1990 – 2024 : Report on methods and data (RMD) Submission 2026. www.eminv-agriculture.de

²⁾ EMEP/EEA air pollutant emission inventory guidebook 2023, EEA Report No 06/2023,

<https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023>.

³⁾

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.

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Stehfest E., Bouwman L. (2006): N₂O and NO emission from agricultural fields and soils under natural vegetation: summarizing available measurement data and modelling of global emissions. *Nutr. Cycl. Agroecosyst.* 74, 207 – 228.

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NID (2026): National Inventory Report 2026 for the German Greenhouse Gas Inventory 1990-2024. Available in April 2026.