3.B - Manure Management

Short description

NFR-Code	Name of Category	Method	AD	EF
3.B	**Manure Management**	**see sub-category details**		
consisting of / including source categories				
3.B.1.a & 3.B.1.b	Cattle	T3 (NH_3), T2 (NO_x, TSP, PM_{10}, $PM_{2.5}$, NMVOC)	NS, RS	CS (NH_3, NO_x), D (TSP, PM_{10}, $PM_{2.5}$, NMVOC)
3.B.2, 3.B.4.d, 3.B.4.e	Sheep, Goats, Horses	T2 (NH_3, NO_x, TSP, PM_{10}, $PM_{2.5}$), T1 (NMVOC)	NS, RS	CS (NH_3, NO_x), D (TSP, PM_{10}, $PM_{2.5}$, NMVOC)
3.B.3	Swine	T3 (NH_3), T2 (NO_x, TSP, PM_{10}, $PM_{2.5}$), T1 (NMVOC)	NS, RS	CS (NH_3, NO_x), D (TSP, PM_{10}, $PM_{2.5}$, NMVOC)
3.B.4.a	Buffalo	until 1995: NO, since 1996: IE (in 3.B.1.b)		
3.B.4.f	Mules and asses	IE (in 3.B.4.e)		
3.B.4.g i-iv	Poultry	T2 (NH_3, NO_x, TSP, PM_{10}, $PM_{2.5}$), T1 (NMVOC)	NS, RS	CS (NH_3, NO_x), D (TSP, PM_{10}, $PM_{2.5}$, NMVOC)
3.B.4.h	Other animals (Deer, Rabbits, Ostrich, Fur animals)	T2 (NH_3, NO_x), T1 (TSP, PM_{10}, $PM_{2.5}$, NMVOC)	AS, M	CS (NH_3, NO_x), D (TSP, PM_{10}, $PM_{2.5}$, NMVOC)

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	Heavy Metals	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	B(a)P	B(b)F	B(k)F	I(x)P	PAHs	HCB	PCB
3.B.1.a	-/-	**L/-**	NA	**L/-**	**L/-**	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.1.b	-/-	**L/T**	NA	**L/T**	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.2	-/-	-/-	NA	-/-	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.3	-/-	-/-	NA	**L/T**	-/-	-/-	**L/-**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.4.d	-/-	-/-	NA	-/-	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.4.e	-/-	-/-	NA	**L/-**	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.4.g.i	-/-	-/-	NA	-/-	-/-	-/-	**L/-**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.4.g.ii	-/-	-/-	NA	-/-	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.4.g.iii	-/-	-/-	NA	-/-	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B.4.g.iv	-/-	-/-	NA	-/-	-/-	-/-	-/-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	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 2024, NH_3 emissions from category 3.B (manure management) were 38.8 % from total agricultural emissions, which is equal to ~ 187.7 kt NH_3. Within those emissions 42.7 % originate from cattle manure (~ 80.2 kt), 32.3 % from pig manure (ca. 60.7 kt), and 12.3 % from poultry manure (~ 23.1 kt). Calculations take into account the impact of anaerobic digestion of manure on the emissions.

NO_x emissions from category 3.B (manure management) contribute only 1.6 % (~ 1.6 kt) to the total agricultural NO_x emissions. They are calculated proportionally to N_2O emissions, see Vos et al. (2026) [1)].

NMVOC emissions from category 3.B (manure management) contributed 97.1 % (291.7 kt) from total agricultural NMVOC emissions (300.6 kt).

In 2024, manure management contributed, respectively, 61.6 % (37.2 kt), 33.3 % (11.6 kt) and 66.4 % (3.5 kt) to the total agricultural TSP, PM_{10} and $PM_{2.5}$ emissions (TSP: 60.4 kt, PM_{10}: 34.7 kt, $PM_{2.5}$: 5.3 kt, respectively).

Activity data for all pollutants

The Federal Statistical Agency and the Statistical Agencies of the federal states carry out surveys in order to collect, along with other data, the head counts of animals. The results of these surveys are used for emission calculations, for details see Vos et al. (2026), Chapter 2.3.

The animal population figures used in the inventory are presented in Table 1. Buffaloes are included in the cattle population figures, mules and asses are included in the horse population figures (IE), see Vos et al. (2026), Chapter 2.3. In the first years after the German reunification in 1990 animal livestock decreased markedly. The head counts for cattle continued to decrease significantly until 2006/2007, followed by a more or less stable period until 2014. Since 2015 a slight decrease occurred. In 2024, dairy cattle numbers are 56.5 % of 1990 numbers, while the total population of other cattle is at 52.3 % of 1990. Swine numbers decreased until 1995 and then increased slightly. Since 2014 a new decrease occurred which became significant between 2020 and 2022 (total swine numbers were reduced by around 18 % within two years). 2024 swine numbers are 66.6 % of 1990 numbers. The 2024 numbers of horses, sheep and goats are, respectively, at 99.6 %, 55.9 % and 183.5 % of 1990.

Figures for broilers and turkeys are showing a massive increase since 1990. Since the year 2013, there have been only minor changes of total poultry numbers. In total, 2024 poultry population figures are at 147.2 % of 1990.

Emissions of deer, rabbits, ostrich and fur-bearing animals are reported since submission 2024. The underlying animal numbers of these categories were estimated in different ways because there are no surveys which collect those animal numbers. However, the impact of those animal categories on the total emissions is small.

A detailed description of the animal numbers used can be found in Vos et al. (2026), chapter 2.3.

Table 1: Population of animals, in [1,000 individuals]

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
dairy cattle	6,354.6	5,229.4	4,569.8	4,236.4	4,183.1	4,284.6	4,217.7	4,199.0	4,100.9	4,011.7	3,921.4	3,832.7	3,809.7	3,712.8	3,589.4
other cattle	13,133.4	10,660.5	9,968.9	8,800.4	8,628.7	8,350.8	8,248.9	8,082.2	7,848.2	7,627.9	7,380.5	7,206.9	7,187.2	7,123.4	6,871.9
buffalo	NO	NO	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
mules and asses	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
horses	1,373.5	1,743.9	1,373.7	1,398.1	1,269.9	1,233.1	1,215.4	1,223.4	1,231.5	1,239.5	1,247.6	1,277.8	1,308.0	1,338.2	1,368.3
sheep	3,266.1	2,990.7	2,743.3	2,643.1	2,245.0	1,866.9	1,851.0	1,863.2	1,846.0	1,813.6	1,780.3	1,794.8	1,805.7	1,847.6	1,824.5
goats	90.0	100.0	140.0	170.0	149.9	135.9	138.8	142.8	146.9	150.9	154.9	157.5	160.0	162.6	165.2
swine	26,502.5	20,387.3	21,767.7	22,742.8	22,244.4	22,978.5	22,761.2	22,920.8	22,019.2	21,625.8	21,622.0	19,728.6	17,692.3	17,525.3	17,642.7
laying hens	53,450.5	47,575.8	48,640.0	43,641.6	41,700.5	50,619.3	51,935.5	52,571.1	53,206.6	53,842.1	54,477.6	54,921.5	55,365.4	55,809.3	56,084.2
broilers	35,393.0	46,625.9	61,940.7	76,045.0	98,389.7	94,909.4	93,791.3	93,458.7	93,126.1	92,793.5	92,461.0	91,004.5	89,548.1	88,091.6	88,091.6
turkeys	5,029.2	6,742.0	8,893.1	10,611.1	11,344.0	12,658.5	12,359.9	12,164.7	11,969.5	11,774.3	11,579.1	10,718.9	9,858.6	8,998.3	8,998.3
pullets	17,210.8	16,149.2	17,284.1	16,050.9	14,827.0	13,828.3	12,921.8	12,736.3	12,550.7	12,365.1	12,179.6	12,253.0	12,326.5	12,399.9	12,399.9
ducks	2,013.7	1,933.7	2,055.7	2,352.2	3,164.3	2,410.8	2,236.4	2,209.1	2,181.9	2,154.6	2,127.4	1,949.3	1,771.2	1,593.1	1,593.1
geese	781.5	617.0	404.8	329.5	278.1	400.8	329.0	327.7	326.3	324.9	323.5	354.2	385.0	415.7	415.7
deer	155.8	204.0	252.3	261.5	270.0	277.4	278.9	280.4	281.9	283.3	284.8	286.3	287.8	289.3	290.8
rabbits	1,851.4	1,565.6	1,268.9	997.0	864.2	720.7	691.2	642.7	608.3	593.9	548.4	470.0	430.6	422.8	422.5
ostrich	NO	1.2	2.5	3.7	4.9	7.7	7.4	7.4	7.9	7.4	7.9	6.1	5.1	4.6	4.0
fur animals	179.9	179.9	179.9	153.5	121.7	34.4	24.7	15.0	5.3	5.3	NO	NO	NO	NO	NO

Additional data

Emission calculations in accordance with a Tier 2 or Tier 3 method require data on animal performance (animal weight, weight gain, milk yield, milk protein content, milk fat content, numbers of births, numbers of eggs and weights of eggs) and on the relevant feeding details (phase feeding, feed components, protein and energy content, digestibility and feed efficiency). To subdivide officially recorded total numbers of turkeys into roosters and hens, the respective population percentages need to be known. Details on data requirements for the modelling of emissions from livestock husbandry in the German inventory can be found in Vos et al. (2026), Chapter 2.

Most of the data regarding feed and performance is not available from official statistics and was obtained from literature, from publications by agricultural associations, from guidelines for agricultural consulting in Germany and from expert judgments.

For 1991, 1995 and 1999, frequency distributions of feeding strategies, husbandry systems (shares of pasturing/stabling; shares of various housing methods), storage types as well as techniques of farm manure spreading were obtained with the help of the RAUMIS agricultural sector model (Regionalisiertes Agrar- und UmweltInformationsystem für Deutschland/ Regionalised agricultural and environmental information system for Germany). RAUMIS has been developed and is operated by the Institute of Rural Studies of the Thünen Institute (Federal Research Institute for Rural Areas, Forestry and Fisheries). For an introduction to RAUMIS see Weingarten (1995)[2]; a detailed description is provided in Henrichsmeyer et al. (1996)[3].

RAUMIS did not model complete time series but only selected years. RAUMIS data for the years 1991, 1995, and 1999 are used in the inventory for the respective years. For 1990, the data for 1991 is adopted, for the intervening years (1992-1994 and 1996-1998) data gaps were closed by linear interpolation on district level.

For the year 2009, respective data are used that were derived from the 2010 official agricultural census and the simultaneous survey of agricultural production methods (Landwirtschaftliche Zählung 2010, Statistisches Bundesamt/ Federal Statistical Office) as well as the 2011 survey on manure application practices (Erhebung über Wirtschaftsdüngerausbringung, Statistisches Bundesamt/ Federal Statistical Office). The gaps between the latest RAUMIS model data (1999) and the first official data (2009) were closed by linear interpolation on district level. For the year 2015, data on techniques of farm manure spreading from the 2016 official agricultural census (Agrarstrukturerhebung 2016, Statistisches Bundesamt / Federal Statistical Office) are used. For the year 2019 data from the 2020 official agricultural census (Landwirtschaftszählung 2020, LW20) are used for housing systems, storage systems and manure spreading systems.

For 2010 to 2018 the housing and storage systems data was linearly interpolated between the censuses of 2010 and 2020.The data on manure spreading techniques was linearly interpolated between the census data from 2009 and 2015, and for 2016 to 2018 between the censuses conducted in 2016 and 2020. In addition, it was taken into account that, as of 2012, slurry spread on bare soil has to be incorporated within four hours. The data from the 2020 official agricultural census (DESTATIS, 2020)[4)]is being used for subsequent years until more current data is available.

For a description of the RAUMIS data, the data from official surveys and additional data from other sources see Vos et al. (2026), Chapter 2.5. Time series of frequency distributions of housing systems, storage systems and application techniques as well as the corresponding emission factors are provided in NID 2026[5)], Chapter 17.3.1.

Since submission 2026 transports of manure, energy crops and digestates between NUTS 3 regions are simulated in the calculation model. This does not have major influence on the emissions of the whole country, but changes the distribution of emissions between single NUTS 3 regions. For details on the methodology, see Vos et al. (2026), Chapter 1.2.

NH_3 and NO_x

Method

N in manure management

N excretion

In order to determine NH_3 and NO_x emissions from manure management of a specific animal category, the individual N excretion rate must be known as well as, for NH_3, the TAN content of the N excretions. Default excretion rates are provided by IPCC Guidelines and default TAN contents can be found in the EMEP Guidebook, 2023[6)]. However, the German agricultural emission inventory uses N mass balances to calculate the N excretions and the TAN contents of almost all reported animal categories. N mass balance calculations (see below) consider N intake with feed, N retention due to growth, N contained in milk and eggs, and N in offspring. Table 2 presents national means of N excretions and TAN contents. For methodological details and mass balance input data see Vos et al. (2026), Chapter 4.2 as well as Chapter 4.1.2. For dairy cows N excretion is estimated based on milk urea content since submission 2026, for details see Vos et al. (2026) Chapter 4.1.2. This allows an estimation that is based on the actual feeding of the dairy cows, thus it is possible to depict the effect of feeding changes in N excretions. Milk urea contents are obtained from the agricultural information services company vit (Vereinigte Informationssysteme Tierhaltung w.V.) and directly by four state control associations, who operate a separate database. Each record includes farm-aggregated information regarding herd size, milk yield, milk urea, fat and protein contents, milking day, and racial composition of the herd. For the time between 2005 and 2022 over 10 million milk urea contents at herd-level were obtained. For the purpose of the inventory these were aggregated on district level, weighted by herd size. For the years from 1990-2004 the values of 2005 were taken, for 2023 and 2024 the values of 2022.

Table 2: National means of N excretions and TAN contents

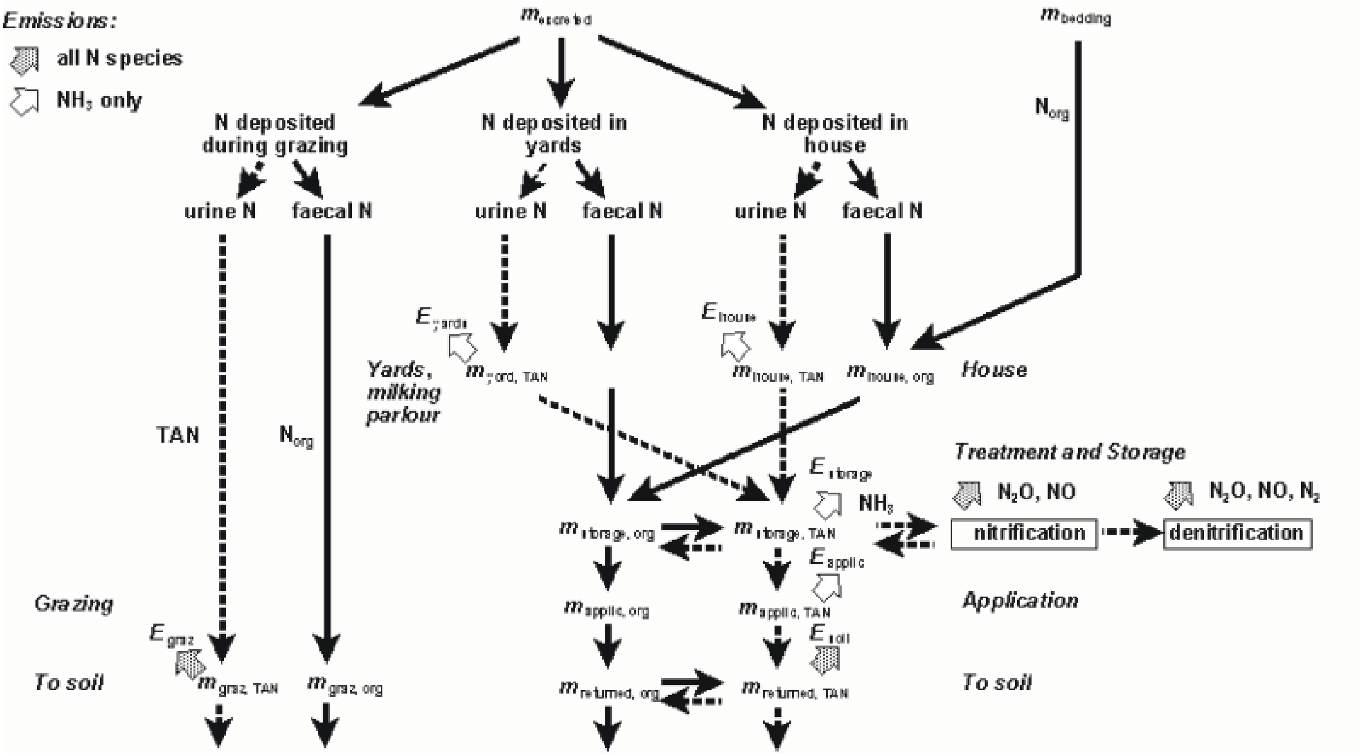
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
mean N excretions in kg per animal place															
dairy cattle	106.3	110.8	114.3	117.5	114.3	115.2	116.8	118.7	120.3	121.4	119.7	117.0	116.1	118.6	120.2
other cattle	37.9	39.9	41.3	41.2	42.1	42.5	42.5	42.7	42.9	43.4	43.7	43.9	43.9	44.2	44.4
horses	48.2	48.1	49.0	48.8	48.8	54.0	55.0	56.1	57.1	58.2	59.2	59.2	59.2	59.2	59.2
sheep	7.7	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
goats	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
swine	12.8	13.1	13.0	12.8	12.6	12.4	12.4	12.3	12.2	12.1	12.1	12.3	12.2	12.2	12.3
laying hens	0.81	0.78	0.76	0.79	0.86	0.88	0.89	0.89	0.89	0.89	0.90	0.90	0.90	0.90	0.91
broilers	0.48	0.37	0.37	0.36	0.35	0.40	0.40	0.40	0.41	0.40	0.39	0.39	0.40	0.41	0.42
turkeys	2.0	2.0	2.0	2.2	2.2	2.3	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.1	2.1
pullets	0.38	0.35	0.32	0.33	0.33	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
ducks	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
geese	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
deer	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
rabbits	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
ostrich	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60	15.60
fur animals	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59
mean TAN contents in %															
dairy cattle	51.3	48.9	47.3	45.9	44.6	43.7	43.3	43.4	42.9	42.3	41.5	41.1	41.4	40.5	39.9
other cattle	65.5	65.7	65.7	65.7	66.0	66.3	66.4	66.4	66.4	66.4	66.4	66.3	66.3	66.3	66.3
horses	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
sheep	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
goats	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
swine	72.0	71.7	71.1	71.8	72.3	71.5	71.3	71.2	71.0	70.9	70.7	70.8	70.6	70.5	70.4
laying hens	70.2	69.6	69.0	69.3	70.0	70.2	70.1	70.1	70.2	70.2	70.1	70.1	70.2	70.3	70.2
broilers	60.8	58.9	56.4	53.5	50.0	46.9	46.5	46.1	45.7	45.2	44.8	44.8	44.8	44.8	44.8
turkeys	64.7	64.7	63.0	63.9	63.0	63.5	63.5	63.5	63.0	63.0	62.1	62.1	62.1	62.1	62.1
pullets	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4
ducks	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9
geese	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
deer	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
rabbits	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
ostrich	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
fur animals	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0

N mass flow and emission assessment

The calculation of the emissions of NH_3, N_2O, NO_x and N_2 from German animal husbandry is based on the so-called N mass flow approach (e. g. Dämmgen and Hutchings, 2008 [7)]). This approach differentiates between N excreted with faeces (organic nitrogen Norg, i. e. undigested feed N) and urine (total ammoniacal nitrogen TAN, i. e. fraction of feed N metabolized). The N flow within the manure management system is treated as depicted in the figure below. This method reconciles the requirements of both the Atmospheric Emission Inventory Guidebook for NH_3 emissions (EMEP, 2023), and the IPCC guidelines for greenhouse gas emissions (IPCC (2006)[8)]. Reidy et al. (2008),[9)], showed for several European countries (Germany, the Netherlands, Switzerland, United Kingdom) that their N-flow based inventory models yielded, in spite of national peculiarities, comparable results as long as standardised data sets for the input variables were used.

Not explicitly shown in the N mass flow scheme is air scrubbing in housing and anaerobic digestion of manure. These issues are separately described further below. Note that emissions from grazing and application are reported in sector 3.D.



General scheme of N flows in animal husbandry

m: mass from which emissions may occur. Narrow broken arrows: TAN (total ammoniacal nitrogen); narrow continuous arrows: organic N. The horizontal arrows denote the process of immobilisation in systems with bedding occurring in the house, and the process of mineralisation during storage, which occurs in any case. Broad arrows denote N-emissions assigned to manure management (E_{yard} NH_3 emissions from yards; E_{house} NH_3 emissions from house; $E_{storage}$ NH_3, N_2O, NO_x and N_2 emissions from storage; E_{applic} NH_3 emissions during and after spreading; E_{graz} NH_3, N_2O, NO_x and N_2 emissions during and after grazing; E_{soil} N_2O, NO_x and N_2 emissions from soil resulting from manure input).

The model allows tracing of the pathways of the two N fractions after excretion. The various locations where excretion may take place are considered. The partial mass flows through the livestock systems are represented. During storage Norg can be transformed into TAN and vice versa. Both, the way and the magnitude of such transformations may be influenced by manure treatment processes like, e. g., anaerobic digestion where a considerable fraction of Norg is mineralized to TAN. For details see Vos et al. (2026), Chapter 4.2. Wherever NH_3 is emitted, its formation is related to the amount of the TAN present. N_2O emissions are related to the total amount of N available (Norg + TAN). NO_x emissions (i. e. NO emissions) are calculated proportionally to the N_2O emissions, see section 'Emission factors'. Note that the N_2O, NO_x and N_2 emissions from the various storage systems include the respective emissions from the related housing systems.

Air scrubber systems in swine and poultry housings

For pig and poultry production the inventory model considers the effect of air scrubbing. 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) supplemented by data from the 2020 agricultural census. 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: systems of “first class” that remove both NH_3 and particles, and ”second class” systems that remove only particles reliably and have a NH_3 removal efficiency of 20%.

According to KTBL, 7.6 % of all pig places were equipped with ”first class” systems in 2024, another 12.6 % were equipped with “second class” systems. For poultry 0.9 % of all laying hen places and 2.5 % of all broiler places were equipped with air scrubbers that remove both NH_3 and particles. The amounts of NH_3-N removed by air scrubbing are completely added to the pools of total N and TAN for landspreading. For details see Vos et al. (2026), Chapter 4.2.2.

Anaerobic digestion of manure

According to IPCC (2006), anaerobic digestion of manure is treated like a particular storage type. In the German Inventory it comprises three sub-compartments (pre-storage, fermenter and storage of digestates). For details see Vos et al. (2026), Chapters 2.6 and 4.2.5. The resulting digestates are considered as liquid. Two different types of digestates storage systems are considered: gastight storage and open tank. For open tanks formation of a natural crust because of co-fermentation with energy crops is taken into account. Furthermore, the modelling of anaerobic digestion and spreading of the digestates takes into account that the amount of TAN in the digestates is higher than in untreated slurry and that the frequencies of spreading techniques differ from those for untreated slurry.

NH_3 and NO emissions occur from pre-storage of solid manure, from non-gastight storage of digestates and from application of digestates (NH_3 emissions and NO emissions from application of digested manure are reported in 3.D.a.2.a). There are no such emissions from pre-storage of slurry, from the fermenter and from gastight storage of digestates. Note that NH_3 and NO emissions calculated with respect to the digestion of animal manures do not comprise the contributions by co-digested energy crops. The latter are dealt with separately in 3.D.a.2.c and 3.I.

Emission Factors

Application of the N mass flow approach requires detailed emission factors for NH_3, N_2O, NO_x and N_2 describing the emissions from the various housing and storage systems.

The detailed NH_3 emission factors are, in general, related to the amount of TAN available at the various stages of the N flow chain. The emission factors for laying hens, broilers, pullets, ducks and turkeys are related to N. Most NH_3 emission factors are country-specific but some are taken from EMEP (2023). No specific NH_3 emission factors are known for the application of digested manure. However, due to co-fermentation with energy crops, the viscosity of digested manure resembles that of untreated cattle slurry. Hence, the emission factors for untreated cattle slurry are adopted for the application of digested manure. For the detailed emission factors of livestock husbandry see Vos et al. (2026), Chapter 4.3.

The detailed emission factors for N_2O, NO_x and N_2 relate to the amount of N available which is N excreted plus, in case of solid manure systems, N input with bedding material. The N_2O emission factors are taken from IPCC (2019)[10]. The emission factors for NO_x and N_2 are approximated as being proportional to the N_2O emission factors, i. e. the NO-N and N_2 emission factors are, respectively, one-tenth and three times the value of the N_2O-N emission factor, see Vos et al. (2026), chapter 4.2.4. This proportionality is also applied to anaerobic digestion of manure, where N_2O emissions occur from pre-storage of solid manure and non-gastight storage of digestates with the emission factors being those used for normal storage of solid manure and the storage of untreated slurry with natural crust provided by IPCC (2019). Note that the inventory model calculates NO rather than NOx. The conversion of NO emissions into NO_x emissions is achieved by multiplying the NO emissions with the NO_2/ NO molar weight ratio of 46/30. This relationship also holds for NO and NO_x emission factors.

Table 3 shows the implied emission factors of NH_3 and NO_x for the various animal categories (housing and storage) These emission factors normalize emissions from an animal category as the ratio of the total emission to the respective number of animals. The overall German NH_3 IEF for manure application is reported in section 3.D.a.2.a.

Table 3: IEF for NH_3 & NO_x from manure management, in [kg per animal place]

	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Ammonia															
dairy cattle	9.3	9.7	10.1	10.8	10.7	10.9	11.0	11.3	11.5	11.5	11.1	10.7	10.7	10.6	10.6
other cattle	5.7	5.8	5.9	6.2	6.6	6.3	6.2	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
horses	13.5	13.5	13.7	13.7	13.7	14.8	15.0	15.3	15.5	15.7	16.0	16.0	16.0	16.0	16.0
sheep	0.83	0.82	0.84	0.83	0.84	0.83	0.83	0.83	0.82	0.83	0.83	0.82	0.82	0.82	0.83
goats	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
swine	4.45	4.36	4.24	4.15	3.94	3.68	3.63	3.58	3.54	3.49	3.45	3.48	3.38	3.40	3.44
laying hens	0.213	0.205	0.210	0.207	0.136	0.128	0.127	0.126	0.124	0.123	0.121	0.121	0.120	0.121	0.121
broilers	0.143	0.108	0.104	0.098	0.087	0.091	0.089	0.089	0.088	0.087	0.084	0.085	0.082	0.086	0.087
turkeys	0.797	0.797	0.800	0.877	0.833	0.845	0.845	0.844	0.835	0.827	0.771	0.770	0.764	0.761	0.767
pullets	0.125	0.116	0.105	0.104	0.097	0.091	0.092	0.093	0.095	0.096	0.098	0.097	0.098	0.101	0.102
ducks	0.193	0.193	0.193	0.192	0.190	0.184	0.183	0.183	0.185	0.184	0.187	0.187	0.183	0.183	0.183
geese	0.386	0.385	0.385	0.384	0.381	0.375	0.379	0.379	0.382	0.382	0.383	0.383	0.382	0.381	0.381
deer	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
rabbits	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228	0.228
ostrich	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
fur animals	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123	1.123
Nitrogen oxides															
dairy cattle	0.163	0.154	0.163	0.168	0.158	0.146	0.146	0.147	0.148	0.148	0.143	0.137	0.136	0.140	0.142
other cattle	0.064	0.068	0.071	0.076	0.079	0.077	0.077	0.077	0.078	0.078	0.078	0.077	0.077	0.078	0.078
horses	0.169	0.169	0.172	0.171	0.171	0.184	0.187	0.190	0.193	0.196	0.198	0.198	0.198	0.198	0.198
sheep	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
goats	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
swine	0.013	0.015	0.015	0.016	0.016	0.014	0.014	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012
laying hens	0.00027	0.00026	0.00026	0.00030	0.00035	0.00037	0.00036	0.00036	0.00023	0.00023	0.00024	0.00024	0.00023	0.00024	0.00024
broilers	0.00016	0.00012	0.00012	0.00013	0.00014	0.00016	0.00016	0.00016	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
turkeys	0.00068	0.00068	0.00070	0.00085	0.00095	0.00091	0.00094	0.00094	0.00069	0.00066	0.00061	0.00061	0.00060	0.00058	0.00060
pullets	0.00013	0.00012	0.00011	0.00013	0.00015	0.00014	0.00014	0.00014	0.00009	0.00009	0.00009	0.00009	0.00009	0.00010	0.00010
ducks	0.00024	0.00024	0.00024	0.00025	0.00026	0.00027	0.00028	0.00027	0.00021	0.00021	0.00022	0.00022	0.00021	0.00021	0.00021
geese	0.00025	0.00025	0.00025	0.00029	0.00032	0.00032	0.00030	0.00030	0.00023	0.00023	0.00024	0.00024	0.00023	0.00022	0.00022
deer	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
rabbits	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269	0.00269
ostrich	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126	0.00126
fur animals	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508	0.01508

Trend discussion for Key Sources

Dairy cattle, other cattle and swine are key sources of NH_3 emissions from manure management. The time series of the total NH_3 emissions from all three categories are predominantly driven by the development of the animal numbers, see Table 1. However, the effect of decreasing animal numbers is partly compensated by the continuously increasing animal performance. This leads to increasing N excretions per animal, see Table 2, which, in principle, is reflected by increasing implied emission factors, see Table 3. For swine the IEF is decreasing over time due to lower raw protein contents in feed and the use of air scrubbing systems that, to a high degree, remove NH_3 from the housings.

For NO_x there are no key categories.

Recalculations

All timeseries of the emission inventory have completely been recalculated. Tables 4 and 5 compare the recalculated time series for NH_3 and NO_x from 3B with the respective data of last year’s submission.

For NH3 there are many reasons for very different emissions compared to last year’s submission. For dairy cows the new methodology to claculate N and TAN excretions (see main page of the agricultural sector **recalculation No. 3**) results in general in lower emissions. The upward correction of historic milk yields (**recalculation No. 4**) results in higher emissions. In combination these two recalculations result in lower emissions, especially in more recent years. The subdivision of the sows category in gilts and old sows (**recalculation No. 5**) is the main reason for lower emissions from swine. The adjusted N excretion for horses after 2010 (**recalculation No. 6**) is the main reason for higher emissions from other animals. The addition of substrate transports to biogas plants (**recalculation No. 1**) has a smaller impact on emissions than the other recalculations. This recalculation is the main reason for the changes for emissions from other cattle and poultry but it also affects dairy cattle and swine emissions. Many of the other recalculations have much smaller effects. Overall, the changes result in lower emissions compared with last year’s submission.

The total emissions of NO_x for all years up to 2019 are higher and thereafter a little bit lower than those of submission 2025. The main reasons for this are the recalculations done for dairy cattle (**recalculations No. 3 and No. 4**). Up to the year 2019 the effect of the adjusted milk yields (resulting in higher emissions) is higher than the effect of the new methodology to calculate N emissions which leads to lower N excretions especially in more recent years. All other reasons listed above regarding NH_3 have similar effects on NO_x emissions. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 4: Comparison of NH_3 emissions [kt] with previous submission

		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total	**current submission**	297.22	250.13	245.22	244.46	235.19	231.40	227.54	226.84	220.30	215.27	209.68	199.90	190.21	188.78	187.67
	previous submission	300.67	252.12	248.41	248.80	242.06	237.98	233.87	231.70	224.95	220.40	216.51	208.17	197.88	196.54	
	absolute change	-3.45	-1.99	-3.20	-4.33	-6.87	-6.58	-6.33	-4.86	-4.65	-5.14	-6.83	-8.27	-7.67	-7.76	
	relative change [%]	-1.15	-0.79	-1.29	-1.74	-2.84	-2.76	-2.71	-2.10	-2.07	-2.33	-3.15	-3.97	-3.88	-3.95	
Dairy cattle	**current submission**	58.81	50.52	46.08	45.56	44.83	46.63	46.48	47.61	46.96	46.11	43.41	40.83	40.65	39.50	38.05
	previous submission	60.08	50.88	47.58	47.96	49.01	51.16	50.96	50.81	50.34	50.41	49.61	48.53	48.11	47.56	
Other cattle	**current submission**	75.09	61.37	58.84	54.44	57.03	52.31	51.04	49.59	47.76	46.24	44.92	43.89	43.75	43.65	42.16
	previous submission	75.09	61.37	58.84	54.43	57.07	52.45	51.18	49.73	47.86	46.37	45.09	44.10	43.95	43.75	
Swine	**current submission**	118.02	88.90	92.30	94.41	87.70	84.59	82.66	82.07	78.05	75.42	74.52	68.60	59.81	59.50	60.67
	previous submission	120.20	90.53	93.99	96.33	90.18	87.72	85.80	85.33	81.27	78.46	77.66	71.70	62.66	62.12	
poultry	**current submission**	23.31	22.67	26.15	28.06	25.82	27.64	27.13	26.92	26.51	26.09	25.03	24.31	23.25	22.86	23.06
	previous submission	23.31	22.67	26.16	28.07	26.00	27.82	27.37	27.17	26.72	26.32	25.23	24.50	23.43	22.93	
Other animals	**current submission**	22.00	26.67	21.85	22.00	19.81	20.24	20.23	20.64	21.02	21.42	21.80	22.27	22.75	23.27	23.74
	previous submission	22.00	26.67	21.85	22.00	19.81	18.82	18.56	18.66	18.75	18.84	18.92	19.32	19.73	20.18	

Table 5: Comparison of NO_x emissions [kt] with previous submission

		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total	**current submission**	2.537	2.211	2.087	2.062	1.997	1.891	1.867	1.854	1.800	1.762	1.710	1.633	1.597	1.607	2.537
	previous submission	2.403	2.119	2.023	2.014	1.980	1.878	1.848	1.822	1.783	1.750	1.716	1.658	1.619	1.621	
	absolute change	0.13	0.09	0.06	0.05	0.02	0.01	0.02	0.03	0.02	0.01	-0.01	-0.02	-0.02	-0.01	
	relative change [%]	5.60	4.35	3.20	2.38	0.84	0.67	1.01	1.77	0.97	0.65	-0.40	-1.48	-1.39	-0.86	
Dairy cattle	**current submission**	1.036	0.807	0.743	0.712	0.660	0.623	0.618	0.618	0.608	0.593	0.562	0.523	0.519	0.520	0.508
	previous submission	0.892	0.708	0.672	0.658	0.634	0.607	0.600	0.590	0.585	0.580	0.570	0.549	0.544	0.545	
Other cattle	**current submission**	0.843	0.726	0.711	0.668	0.683	0.647	0.637	0.625	0.609	0.595	0.576	0.557	0.553	0.556	0.537
	previous submission	0.843	0.726	0.711	0.668	0.684	0.652	0.642	0.630	0.613	0.600	0.582	0.565	0.561	0.558	
Swine	**current submission**	0.351	0.313	0.326	0.366	0.358	0.316	0.308	0.303	0.286	0.271	0.266	0.241	0.208	0.209	0.213
	previous submission	0.360	0.319	0.332	0.372	0.367	0.332	0.322	0.318	0.300	0.286	0.281	0.258	0.224	0.222	
poultry	**current submission**	0.026	0.025	0.029	0.035	0.043	0.048	0.048	0.048	0.033	0.032	0.032	0.032	0.030	0.030	0.030
	previous submission	0.026	0.025	0.029	0.034	0.042	0.048	0.047	0.047	0.046	0.044	0.042	0.040	0.040	0.039	
Other animals	**current submission**	0.282	0.340	0.279	0.281	0.253	0.256	0.256	0.261	0.265	0.270	0.275	0.280	0.286	0.293	1.249
	previous submission	0.282	0.340	0.279	0.281	0.253	0.240	0.236	0.238	0.239	0.240	0.241	0.246	0.251	0.257	

Planned improvements

No improvements are planned at present.

NMVOC

In 2024, NMVOC emissions from manure management amount to 291.7 kt which is 97.1 % of total NMVOC emissions from the agricultural sector. 84.1 % thereof originate from cattle, 15.9 % from other animals.

Method

The Tier 2 methodology provided by EMEP (2023)-3B-26 was used to assess the NMVOC emissions from manure management for dairy cattle and other cattle. For all other animals the Tier 1 methodology (EMEP (2023)-3B-17) was used. The use of the Tier 2 methodology yields NMVOC emissions which formally could be reported in the sectors 3.D.a.2.a (application of manure to soils) 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 key note IE is used for NMVOC emissions.

Activity data

Animal numbers serve as activity data, see Table 1.

Emission factors

For the Tier 2 methodology applied to dairy cattle and other cattle the following data was used:

- gross feed intake in MJ per year, country specific data from the annual reporting of greenhouse gas emissions, see NID 2026, Chapter 5.1.3.3,
- proportion x_{house} of the year the animals spend in the livestock building: country specific data, being equal to 1 – x_{graz} with x_{graz} the proportion of the year spent on pasture, see NID 2026, Chapter 17.3.1,
- $FRAC_{silage}$: 1 as proposed by EMEP (2023)-3B-27, since silage feeding for cattle is considered dominant in Germany
- $FRAC_{silage\ store}$: 0.25 as proposed by EMEP (2023)-3B-27 for European conditions
- $EF_{NMVOC,\ silage\_feeding}$, $EF_{NMVOC,\ house}$, $EF_{NMVOC,\ graz}$ are taken from EMEP (2023)-3B-31, table 3.11 as 0.0002002, 0.0000353 and 0.0000069 kg NMVOC/MJ feed intake, respectively,
- $EF_{NH_3,storage}$, $EF_{NH_3,building}$ and $EF_{NH_3,application}$ are taken from the NH_3 reporting (see above and 3.D).

For all other animal categories the Tier 1 emission factors for NMVOC were used as provided in EMEP (2023)-3B-17, Table 3.4. For horses the emission factors for feeding with silage was chosen, for all other animals the emission factors for feeding without silage. Due to missing country-specific emission factors or emission factors that do not correspond to the inventory's animal categories, the emission factors provided in EMEP (2023)-3B-17, Table 3.4, were used to define specific emission factors for weaners, boars, lambs, ponies/light horses and pullets, ostriches, and deer see Vos et al. (2026), Chapter 4.3.3. The implied emission factors given in Table 4 relate the overall NMVOC emissions to the number of animals in each animal category. The IEFs for dairy cattle and other cattle are much higher than the EMEP Tier 1 EF, which are 17.937 kg NMVOC for dairy cattle and 8.902 kg NMVOC for other cattle. The only possible explanation for those huge differences is that the EMEP Tier 2 and Tier 1 methods are not consistent.

The IEFs for the other categories provided in Table 6 correspond to the EMEP Tier 1 emission factors, except for horses, sheep and swine. These categories comprise subcategories with different emission factors so that their overall IEFs in Table 4 represent subpopulation-weighted national mean values. Note that other poultry in Germany includes not only geese and ducks but also pullets. For pullets no default EF is given in the EMEP guidebook (EMEP, 2023), hence the EF of broilers has been adopted (because of similar housing). This assumption significantly lowers the overall IEF of other poultry (in Table 6 the IEFs are listed separately for each poultry category). The IEF of the sheep category is significantly lower than the EMEP Tier 1 emission factor, because for lambs the EF is assumed to be 40% lower compared to an adult sheep in accordance with the difference in N excretion between lambs and adult sheep.

Table 6: IEF for NMVOC from manure management, in [kg NMVOC per animal place]

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
dairy cattle	32.914	35.430	38.490	39.726	40.290	40.898	41.328	41.220	41.988	42.823	43.405	43.556	43.173	44.716	45.579
other cattle	12.400	12.298	12.406	12.247	12.207	11.835	11.763	11.730	11.703	11.732	11.791	11.866	11.848	11.880	11.905
horses	6.497	6.491	6.688	6.660	6.644	6.646	6.648	6.651	6.654	6.657	6.660	6.659	6.658	6.657	6.656
sheep	0.131	0.131	0.132	0.132	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
goats	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542
swine	0.695	0.698	0.690	0.682	0.669	0.651	0.649	0.648	0.648	0.647	0.642	0.645	0.643	0.644	0.644
laying hens	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
broilers	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
turkeys	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489
pullets	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
ducks	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489
geese	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489
deer	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
rabbits	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
ostrich	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489
fur animals	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941

Trend discussion for Key Sources

Dairy cattle and other cattle are key sources of NMVOC emissions from manure management. The total NMVOC emissions from both animal categories strongly correlate with the animal numbers given in Table 1 (dairy cattle: $R^2 = 0.90$; other cattle: $R^2 = 0.99$).

Recalculations

All timeseries of the emission inventory have completely been recalculated. Table 7 compares the recalculated time series of the NMVOC emissions from 3.B with the respective data of last year's submission. The recalculated total emissions are higher. For dairy cattle and other cattle emissions are higher due to changes of NH_3 emissions which have impact on the Tier 2 methodology which is applied for cattle NMVOC emissions. For other animals there are no changes compared with the previous submission. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 7: Comparison of NMVOC emissions [kt] with previous submission

		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total	**current submission**	418.62	362.01	346.77	325.36	324.20	325.33	322.01	318.62	314.16	311.13	306.95	300.63	296.10	296.66	291.74
	previous submission	415.22	357.45	342.28	320.98	320.35	322.59	318.93	315.55	311.20	307.95	303.73	297.43	293.26	292.11	
	absolute change	3.39	4.56	4.49	4.38	3.85	2.74	3.07	3.07	2.96	3.18	3.22	3.20	2.84	4.55	
	relative change [%]	0.82	1.27	1.31	1.36	1.20	0.85	0.96	0.97	0.95	1.03	1.06	1.07	0.97	1.56	
Dairy cattle	**current submission**	209.16	185.28	175.89	168.29	168.54	175.23	174.31	173.08	172.19	171.79	170.21	166.94	164.48	166.02	163.60
	previous submission	205.77	180.73	171.39	163.89	164.40	171.96	170.78	169.61	168.80	168.25	166.61	163.33	161.27	161.23	
Other cattle	**current submission**	162.85	131.10	123.68	107.78	105.33	98.83	97.03	94.80	91.85	89.49	87.02	85.52	85.15	84.63	81.81
	previous submission	162.85	131.10	123.68	107.80	105.62	99.36	97.49	95.21	92.27	89.86	87.40	85.93	85.52	84.87	
Other animals	**current submission**	46.61	45.63	47.21	49.29	50.33	51.27	50.67	50.73	50.12	49.84	49.72	48.17	46.47	46.01	46.33
	previous submission	46.61	45.63	47.21	49.29	50.33	51.27	50.67	50.73	50.12	49.83	49.72	48.17	46.47	46.01	

Planned improvements

No improvements are planned at present.

Particle emissions

In 2024, TSP emissions from manure management amount to 60.4 % of total emissions from the agricultural sector. Of these emissions 23.9 % originate from cattle, 32.9 % from pigs, and 41.6 % from poultry.

34.7 % of total PM_{10} emissions from the agricultural sector are caused by manure management, where 33.3 % originate from cattle, 15.3 % from pigs, and 47.0 % from poultry.

66.4 % of total $PM_{2.5}$ emissions from the agricultural sector are caused by manure management, where 76.5 % originate from cattle, 2.4 % from pigs, and 16.7 % from poultry.

Method

EMEP (2013-3B-26) provided a Tier 2 methodology. In the 2023 Guidebook (EMEP, 2023), this methodology has been replaced by a Tier 1 methodology. However, EF for cattle derived with the EMEP 2013 Tier 2 methodology remained unchanged. Therefore, the EMEP 2013[11)] methodology was kept for cattle. For swine the EMEP 2013 methodology was formally kept but the EMEP 2023 Tier 1 EF was used both for slurry and solid based manure management systems. In case the EMEP 2023 EFs are simply rounded EMEP 2013 EFs, the unrounded EMEP 2013 EFs were kept. For rabbits the EFs from The Netherlands' inventory were adopted (Huis In't Veld et al, 2011)[12)], for ostriches the EFs of goats were used. The inventory considers air scrubber systems in swine and poultry husbandry. For animal places equipped with air scrubbing the emission factors are reduced according to the removal efficiency of the air scrubber systems (90 % for TSP and PM_{10}, 70 % for $PM_{2.5}$). For details see Vos et al. (2026), Chapter 4.2.2.

Activity data

Animal numbers serve as activity data, see Table 1.

Emission factors

Tier 1 emission factors for TSP, PM_{10} and $PM_{2.5}$ from livestock husbandry are provided in EMEP (2023)-3B-18, Table 3.5 and 55, Table A1.7. For cattle the Tier 2 emission factors provided in EMEP (2013)-3B-29, Table 3-11 were used, because they differentiate between slurry and solid manure systems and were also used to develop the EMEP 2023 Tier 1 emissions factors. They are also provided in EMEP (2023)-3B-53, Table A1.7.

The implied emission factors given in Table 8 relate the overall TSP and PM emissions to the number of animals in each animal category. The Guidebook does not indicate whether EFs have considered the condensable component (with or without).

Table 8: IEF for TSP, PM_{10} & $PM_{2.5}$ from manure management

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total suspended particles (TSP)															
dairy cattle	1.2124	1.4016	1.4542	1.4727	1.4969	1.5360	1.5455	1.5541	1.5630	1.5721	1.5721	1.5723	1.5722	1.5723	1.5730
other cattle	0.5194	0.5107	0.5014	0.4903	0.4798	0.4762	0.4759	0.4756	0.4755	0.4748	0.4746	0.4750	0.4755	0.4744	0.4737
horses	0.3514	0.3512	0.3558	0.3552	0.3548	0.3549	0.3549	0.3550	0.3551	0.3551	0.3552	0.3552	0.3551	0.3551	0.3551
sheep	0.0484	0.0478	0.0489	0.0486	0.0489	0.0482	0.0482	0.0482	0.0480	0.0482	0.0482	0.0481	0.0478	0.0480	0.0482
goats	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914	0.0914
swine	0.8260	0.8366	0.8320	0.8218	0.7928	0.7503	0.7453	0.7390	0.7316	0.7231	0.7243	0.7070	0.6881	0.6884	0.6938

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
laying hens	0.1898	0.1898	0.1890	0.1881	0.1869	0.1856	0.1853	0.1854	0.1846	0.1841	0.1838	0.1835	0.1830	0.1828	0.1826
broilers	0.0400	0.0400	0.0400	0.0400	0.0400	0.0399	0.0397	0.0396	0.0395	0.0394	0.0394	0.0392	0.0392	0.0391	0.0391
turkeys	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100
pullets	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
ducks	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400
geese	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400
deer	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
rabbits	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107
ostrich	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278
fur animals	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180
PM_{10}															
dairy cattle	0.5557	0.6426	0.6667	0.6752	0.6862	0.7042	0.7086	0.7125	0.7166	0.7208	0.7208	0.7209	0.7208	0.7209	0.7212
other cattle	0.2403	0.2363	0.2320	0.2267	0.2218	0.2201	0.2200	0.2199	0.2198	0.2195	0.2194	0.2196	0.2198	0.2193	0.2190
horses	0.1619	0.1619	0.1639	0.1636	0.1634	0.1634	0.1635	0.1635	0.1635	0.1635	0.1636	0.1636	0.1636	0.1635	0.1635
sheep	0.0194	0.0192	0.0196	0.0195	0.0196	0.0193	0.0193	0.0193	0.0192	0.0193	0.0193	0.0193	0.0192	0.0192	0.0193
goats	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368
swine	0.1241	0.1255	0.1244	0.1225	0.1173	0.1099	0.1088	0.1078	0.1068	0.1054	0.1051	0.1029	0.1001	0.1001	0.1007
laying hens	0.0400	0.0399	0.0398	0.0396	0.0393	0.0391	0.0390	0.0390	0.0389	0.0388	0.0387	0.0386	0.0385	0.0385	0.0384
broilers	0.0200	0.0200	0.0200	0.0200	0.0200	0.0199	0.0198	0.0198	0.0198	0.0197	0.0197	0.0196	0.0196	0.0196	0.0195
turkeys	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100
pullets	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
ducks	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400	0.1400
geese	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400
deer	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
rabbits	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107	0.0107
ostrich	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112
fur animals	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080
$PM_{2.5}$															
dairy cattle	0.3616	0.4181	0.4338	0.4393	0.4465	0.4582	0.4610	0.4636	0.4663	0.4690	0.4690	0.4690	0.4690	0.4690	0.4693
other cattle	0.1574	0.1548	0.1520	0.1487	0.1456	0.1444	0.1443	0.1442	0.1442	0.1440	0.1439	0.1440	0.1442	0.1439	0.1437
horses	0.1027	0.1026	0.1039	0.1038	0.1036	0.1037	0.1037	0.1037	0.1037	0.1037	0.1038	0.1037	0.1037	0.1037	0.1037
sheep	0.0059	0.0059	0.0060	0.0060	0.0060	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
goats	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112
swine	0.0056	0.0057	0.0056	0.0055	0.0053	0.0050	0.0050	0.0049	0.0049	0.0049	0.0048	0.0048	0.0047	0.0047	0.0047
laying hens	0.0030	0.0030	0.0030	0.0030	0.0030	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
broilers	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
turkeys	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
pullets	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
ducks	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180
geese	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320	0.0320
deer	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
rabbits	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
ostrich	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
fur animals	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040

Trend discussion for Key Sources

Swine and laying hens are key sources of TSP emissions from manure management. The total TSP emissions from swine mainly follow the animal numbers given in Table 1 for the earlier years of the time series. However, due to increases in places equipped with air scrubbing and different emission factors of the different housing systems of the five swine subcategories (sows (divided in gilts and old sows), weaners, fattening pigs, boars) and the varying population shares in those housing systems the R^2 of the linear regression is lower than 1 (0.79). For laying hens (R^2 = 0.98) and broilers (R^2 = 0.99), due to the low prevalence of air scrubbing systems TSP emissions almost perfectly correlate with the animal numbers provided in Table 1.

Recalculations

The following table 9 shows the effects of recalculations on emissions of particulate matter. Minimal differences compared with the previous submission are due to the correction of the number of animal places equipped with air scrubbers (**recalculation No. 11**), see main page of the agricultural sector. Further details on recalculations are described in Vos et al. (2026), Chapter 1.3.

Table 9: Comparison of particle emissions (TSP, PM_{10} & $PM_{2.5}$) [kt] with previous submission

TSP, PM_{10}, $PM_{2.5}$ emissions from manure management, in kt																
		1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
TSP	**current submission**	50.36	43.31	44.13	43.37	42.70	43.91	43.56	43.53	42.51	41.85	41.67	39.64	37.71	37.32	37.23
	previous submission	50.36	43.31	44.13	43.37	42.70	43.91	43.57	43.54	42.51	41.80	41.67	39.63	37.71	37.32	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	
	relative change [%]	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.13	0.00	0.00	0.00	0.00	
PM_{10}	**current submission**	14.50	13.12	13.25	13.09	13.32	13.60	13.42	13.37	13.12	12.93	12.79	12.32	11.91	11.69	11.58
	previous submission	14.50	13.12	13.25	13.09	13.32	13.60	13.42	13.37	13.12	12.93	12.79	12.32	11.91	11.69	
	absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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	0.05	0.00	0.00	0.00	0.00	
$PM_{2.5}$	**current submission**	5.11	4.61	4.32	4.04	4.03	4.10	4.05	4.03	3.95	3.88	3.79	3.70	3.66	3.58	3.49
	previous submission	5.11	4.61	4.32	4.04	4.03	4.10	4.05	4.03	3.95	3.88	3.79	3.70	3.66	3.58	
	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	0.01	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)]

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