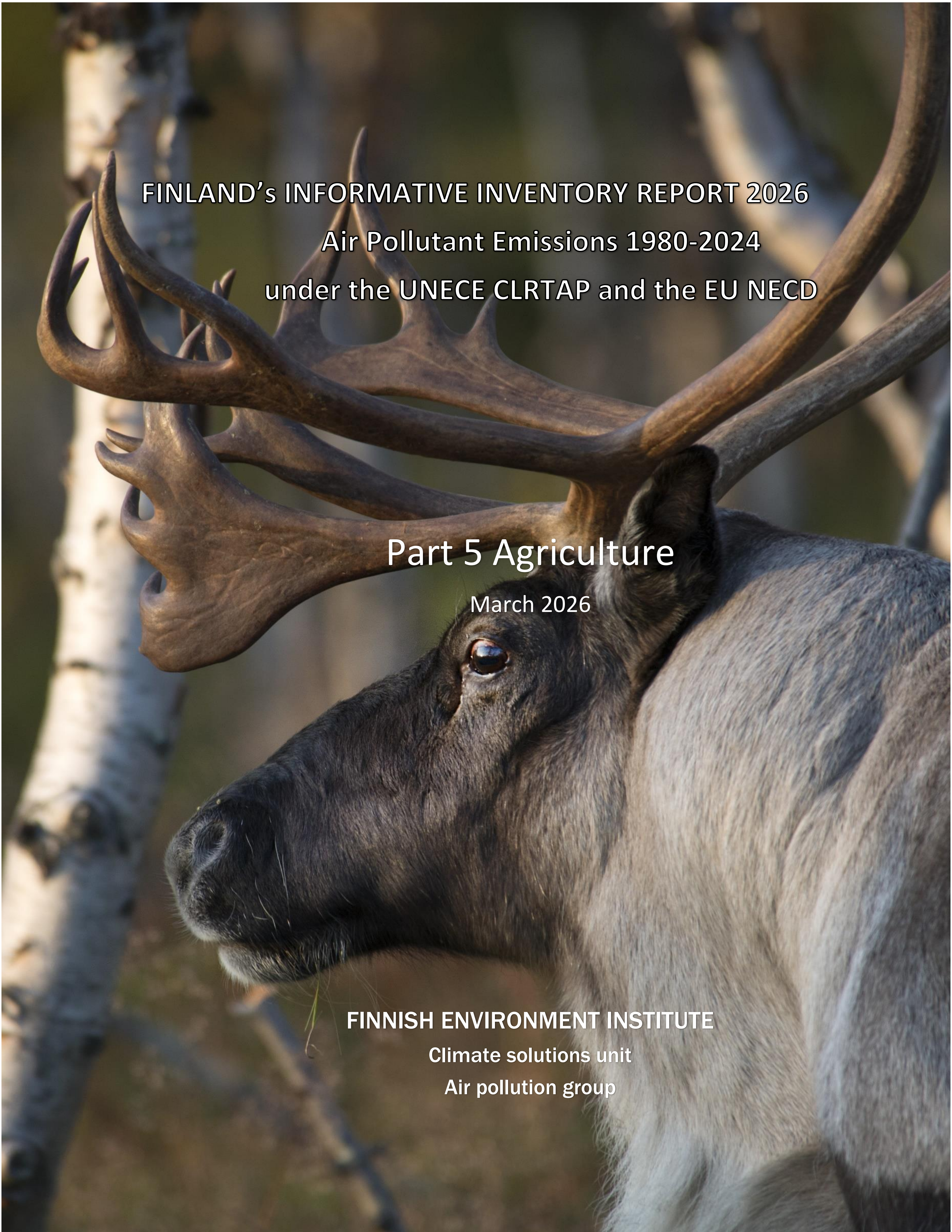


FINLAND's INFORMATIVE INVENTORY REPORT 2026

Air Pollutant Emissions 1980-2024

under the UNECE CLRTAP and the EU NECD

Part 5 Agriculture

March 2026

FINNISH ENVIRONMENT INSTITUTE

Climate solutions unit

Air pollution group

Finland's IIR

Part 5

Agriculture

Picture on the cover page: Reindeer hart (Riku Lumiaho 2015)

FINLAND’S IIR PART 5 - AGRICULTURE

5 AGRICULTURE (NFR 3)

Sub-chapters included under each NFR subcategory

Source category description
Emission trend
Methodological issues
Uncertainty and time series' consistency
Source-specific QA/QC and verification
Source-specific recalculations including changes in response to the review
Source-specific planned improvements

5 AGRICULTURE (NFR 3)

5.1 Overview of the sector

Changes in chapter	
February 2026	JG, TF, JM

Agricultural activities in Finland

Agriculture in Finland is characterized by the northern climate and self-sufficiency in most major agricultural products. Its economic role is declining in terms of GDP and employment in primary production, but together with the food industry and forestry with which it is linked, it forms a significant part of the Finnish economy. Most farms and agricultural land in Finland lie between the 60th and 65th parallel, making it the only country in the world with a significant agricultural sector so far in the north. The percentage of farms concentrating on animal production increases towards the north and east.

Since 1990 there have been structural changes in agriculture, which have resulted in an increase in farm size and a decrease in the numbers of domestic livestock. The number of farms has steadily declined for the last decades. Between 2000 and 2020 their number fell from almost 80,000 to about 45,600 while the amount of arable land slightly increased to a total of almost 2.27 million hectares. As another example, the number of cattle was 38 per cent less in 2020 than in 1990. Agriculture employed 103,000 people in 2020 with a drop of 44 percent from 2000.

Especially for cattle, the decrease in animal numbers is not directly reflected in ammonia emissions. Specifically, this can be seen in the emissions from dairy cows whose milk production per animal and, at the same time, the nitrogen excretion has increased.

The Finnish inventory of air pollutants from agriculture includes emissions from animal husbandry (including manure management, manure application and grazing), application of mineral fertilizers, harvesting, field preparation, storage and handling of agricultural crops, field burning of agricultural residues (forbidden in Finland since the beginning of 2021), use of pesticides, and crop residues, sewage sludge and other organic fertilisers application to soils (Table 5.1a).

Key categories and tier levels for the methodologies used are presented in Table 5.1b.

Table 5.1a. Activities and emissions reported under NFR 3 Agriculture.

		Pollutants						Activities
NFR	**SNAP**	NH_3	**NOx**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NMVOC**	
3B1a	100501	x	x	x	x	x	x	Dairy cattle (dairy cows in production)
3B1b	100502	x	x	x	x	x	x	Non-dairy cattle (all other cattle), bulls,
3B2	100505	x	x	x	x	x	x	Sheep
3B3	100503 100504	x	x	x	x	x	x	Swine, incl. fattening pigs, sows with piglets, weaned pigs (20-50 kg), boars
3B4a	100514	NO	NO	NO	NO	NO	NO	Buffalo
3B4d	100511	x	x	x	x	x	x	Goat
3B4e	100506	x	x	x	x	x	x	Horses and ponies
3B4f	100512	NO	NO	NO	NO	NO	NO	Mules and asses
3B4gi	100507	x	x	x	x	x	x	Laying hens, cockerels
3B4gii	100508	x	x	x	x	x	x	Broilers, broiler hens
3B4giii	100509a	x	x	x	x	x	x	Turkeys
3B4giv	100509b	x	x	x	x	x	x	Other Poultry, incl. laying hen pullets and other poultry
3B4h	100515 100516	x	x	x	x	x	x	Other animals, incl. fur animals and reindeer
NFR	**SNAP**	**Pollutants**						**Activities**
3Da1	100101 100106	NH_3, NOx						Inorganic N fertilisers (includes urea)
3Da2a	100905	NH_3 (calculated in 3B), NOx, NMVOC						Livestock manure applied to soils
3Da2b	100906	NH_3, NOx						Sewage sludge applied to soils
3Da2c	100907	NH_3, NOx						Other organic fertilisers applied to soils
3Da3	100517	NH_3 (calculated in 3B), NOx, NMVOC						Urine and dung deposited by grazing livestock
3Da4	100207	NH_3						Crop residues applied to soils
3Db	100208	-						Indirect emissions from managed soils
3Dc	100901, 100904, 101000	TSP, PM_{10}, $PM_{2.5}$						Farm-level agricultural operations including storage, handling and transport of agricultural products
3Dd	101100	-						Off-farm storage, handling and transport of agricultural products
3De	100201, 100206, 100700	NMVOC						Cultivated crops
3Df	100601, 100604	Emissions of specific pesticide (HCB)						Use of pesticides
3F	100301, 100305	NOx, CO, NMVOC, SOx, NH_3, TSP, PM_{10} $PM_{2.5}$, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn , PAH-4						Field burning of agricultural residues (forbidden in Finland since the beginning

Table 5.1b. Key categories and tier level of methods for the agriculture inventory.

NFR	Fuel	NH_3	Tier	NO_x	Tier	NMVOC	Tier
3B1a		L1, T1	3			L1, T1	2
3B1b		L1, T1	3			L1, T1	2
3B3		L1, T1	3				
3B4gii		T1	3				
3B4h		T1	3				
3Da1		L1, T1	2	L1, T1	1		
3Da2a		L1, T1	3	L1	1	L1	2
3Da2c		T1	1				
3Da3		L1, T1	2				
NFR	**Fuel**	**TSP**	**Tier**	$PM_{2.5}$	**Tier**	PM_{10}	**Tier**
3Dc		L1, T1	2	L1	2	L1, T1	2

5.2 Emission trends

Changes in chapter	
February 2026	JG, JM, TF

Ammonia

Ammonia emissions are generated from manure management, application of nitrogen fertilizers, livestock manure, sewage sludge, other organic fertilisers and crop residues to soils, urine and dung deposited by grazing livestock, and field burning of agricultural residues.

The total agricultural NH_3 emissions in 2024 were 26.2 Gg, of which 14.0 Gg originated from manure management, 3.4 Gg from inorganic N fertilisers, 6.8 Gg from livestock manure applied to soils, 1.0 Gg from deposits by grazing and 0.5 Gg from crop residues. Field burning of agricultural residues is no more allowed since the beginning of 2021. The contribution of NFR sub-sectors to agricultural ammonia emissions is presented in Figure 5.1 and in Table 5.2.

Agricultural ammonia emissions have decreased over the period of 1980-2024 partly due to changes in the economic structure in agriculture followed by an increase in the average farm size and the decrease in the number of small farms. Those changes resulted in the decrease of livestock numbers for all other animals than horses, suckler cows and poultry. The number of horses increased in the recent decades due to the increasing interest in equitation. Number of poultry has increased especially because of increased poultry meat consumption in Finland. In addition, the use of nitrogen fertilisers has been reduced, while manure management has been improved due to measures taken by the farmers as part of an agro-environmental programme aiming at minimising nutrient load to surface waters. Since 2014, the Government decree on limiting certain emissions from agriculture and horticulture (1250/2014) has included additional measures for manure storing and application to limit ammonia emissions. During the recent years there has been a rapid decrease in numbers of fur animals which has quite a substantial impact on ammonia emissions from agriculture.

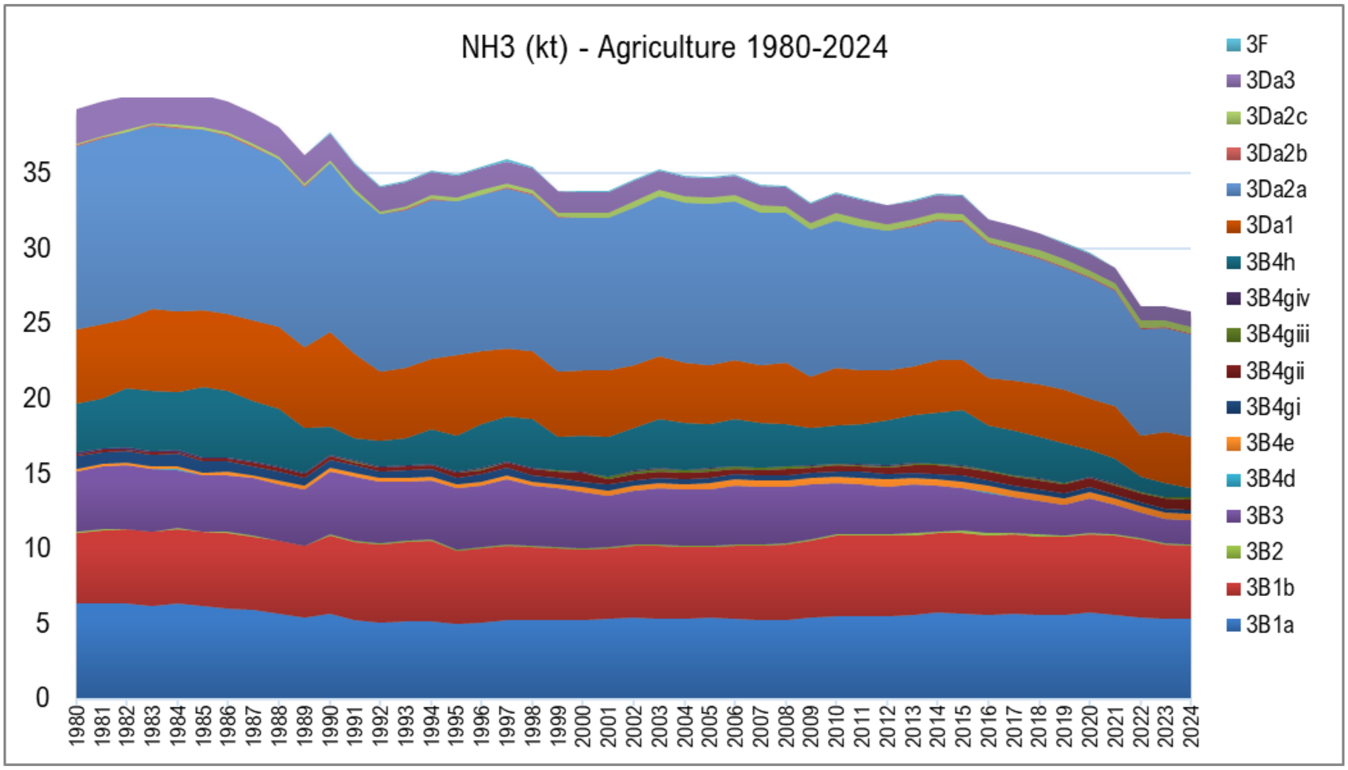


Figure 5.1. Ammonia emissions 1980-2024.

Table 5.2 Ammonia emissions from agricultural sources (Gg) 1980-2024.

Year	NFR 3B	NFR 3D1a	NFR 3Da2a	NFR 3Da1	NFR 3Da2a	NFR 3Da2b	NFR 3Da2c	NFR 3Da3	NFR 3Da4	NFR 3F*	Total
1980	19.68	4.96	12.22	4.96	12.22	0.03	0.14	2.25	0.24	NE	39.52
1981	20.05	4.95	12.37	4.95	12.37	0.04	0.14	2.25	0.23	NE	40.02
1982	20.70	4.65	12.42	4.65	12.42	0.04	0.14	2.22	0.23	NE	40.40
1983	20.53	5.43	12.24	5.43	12.24	0.05	0.15	2.20	0.22	NE	40.82
1984	20.49	5.32	12.23	5.32	12.23	0.05	0.15	2.19	0.21	NE	40.64
1985	20.79	5.15	11.99	5.15	11.99	0.06	0.15	2.11	0.20	NE	40.45
1986	20.55	5.10	11.87	5.10	11.87	0.07	0.16	2.08	0.21	NE	40.03
1987	19.88	5.36	11.54	5.36	11.54	0.07	0.16	2.02	0.20	NE	39.23
1988	19.38	5.40	11.17	5.40	11.17	0.07	0.16	1.95	0.20	NE	38.32
1989	18.04	5.40	10.67	5.40	10.67	0.07	0.16	1.89	0.21	NE	36.46
1990	18.16	6.31	11.25	6.31	11.25	0.04	0.17	1.73	0.20	0.11	37.86
1991	17.41	5.62	10.74	5.62	10.74	0.04	0.19	1.65	0.25	0.10	35.89
1992	17.23	4.58	10.46	4.58	10.46	0.03	0.21	1.58	0.26	0.08	34.36
1993	17.41	4.68	10.50	4.68	10.50	0.03	0.22	1.57	0.26	0.10	34.67
1994	17.97	4.71	10.61	4.71	10.61	0.04	0.24	1.55	0.26	0.10	35.36
1995	17.59	5.38	10.17	5.38	10.17	0.04	0.26	1.44	0.22	0.09	35.10
1996	18.30	4.88	10.37	4.88	10.37	0.04	0.30	1.46	0.20	0.10	35.56
1997	18.80	4.59	10.65	4.59	10.65	0.06	0.29	1.46	0.19	0.10	36.04
1998	18.63	4.55	10.45	4.55	10.45	0.02	0.31	1.42	0.19	0.07	35.57
1999	17.48	4.38	10.22	4.38	10.22	0.02	0.32	1.39	0.20	0.07	34.01
2000	17.53	4.40	10.14	4.40	10.14	0.02	0.32	1.38	0.20	0.10	33.98
2001	17.49	4.40	10.18	4.40	10.18	0.02	0.34	1.35	0.19	0.09	33.97
2002	18.03	4.25	10.48	4.25	10.48	0.02	0.36	1.36	0.19	0.09	34.69
2003	18.66	4.18	10.67	4.18	10.67	0.02	0.37	1.34	0.19	0.08	35.42
2004	18.40	4.04	10.66	4.04	10.66	0.02	0.38	1.33	0.19	0.08	35.01
2005	18.29	3.94	10.73	3.94	10.73	0.02	0.43	1.32	0.19	0.08	34.93
2006	18.70	3.87	10.56	3.87	10.56	0.02	0.45	1.31	0.18	0.07	35.09
2007	18.43	3.79	10.19	3.79	10.19	0.03	0.46	1.30	0.20	0.08	34.39
2008	18.32	4.10	9.95	4.10	9.95	0.03	0.46	1.29	0.19	0.08	34.33
2009	18.09	3.38	9.78	3.38	9.78	0.03	0.45	1.29	0.19	0.07	33.22
2010	18.26	3.85	9.77	3.85	9.77	0.03	0.48	1.29	0.21	0.05	33.89
2011	18.35	3.57	9.54	3.57	9.54	0.04	0.48	1.27	0.20	0.06	33.45
2012	18.55	3.34	9.30	3.34	9.30	0.04	0.43	1.22	0.20	0.06	33.08
2013	18.88	3.26	9.36	3.26	9.36	0.05	0.44	1.21	0.19	0.08	33.38
2014	19.10	3.46	9.35	3.46	9.35	0.05	0.43	1.19	0.19	0.07	33.77
2015	19.25	3.33	9.25	3.33	9.25	0.06	0.43	1.17	0.35	0.07	33.86
2016	18.20	3.24	8.90	3.24	8.90	0.07	0.39	1.15	0.29	0.06	32.22
2017	17.88	3.33	8.66	3.33	8.66	0.07	0.43	1.13	0.27	0.07	31.78
2018	17.44	3.53	8.39	3.53	8.39	0.07	0.48	1.10	0.28	0.05	31.27
2019	17.00	3.61	8.12	3.61	8.12	0.07	0.49	1.08	0.29	0.07	30.67
2020	16.58	3.41	8.04	3.41	8.04	0.07	0.48	1.08	0.29	0.06	29.96
2021	16.00	3.54	7.63	3.54	7.63	0.07	0.46	1.05	0.30	NO	29.06
2022	14.85	2.71	7.09	2.71	7.09	0.07	0.46	1.01	0.30	NO	26.51
2023	14.39	3.44	6.90	3.44	6.90	0.07	0.41	0.98	0.40	NO	26.59
2024	14.02	3.44	6.84	3.44	6.84	0.07	0.45	0.97	0.41	NO	26.20

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

NMVOC

NMVOC emissions are generated in manure management, manure applied to soils, deposits during grazing, cultivated crops and field burning of agricultural residues. A summary of agricultural emissions is presented in Figure 5.2 and in Table 5.3.

Agricultural NMVOC emissions have been decreased over the period 1980–2024 partly due to changes in the economic structure followed by an increase in the average farm size and a decrease in the number of small farms. Those changes resulted in the decrease of livestock numbers except for the number of horses, suckler cows and poultry.

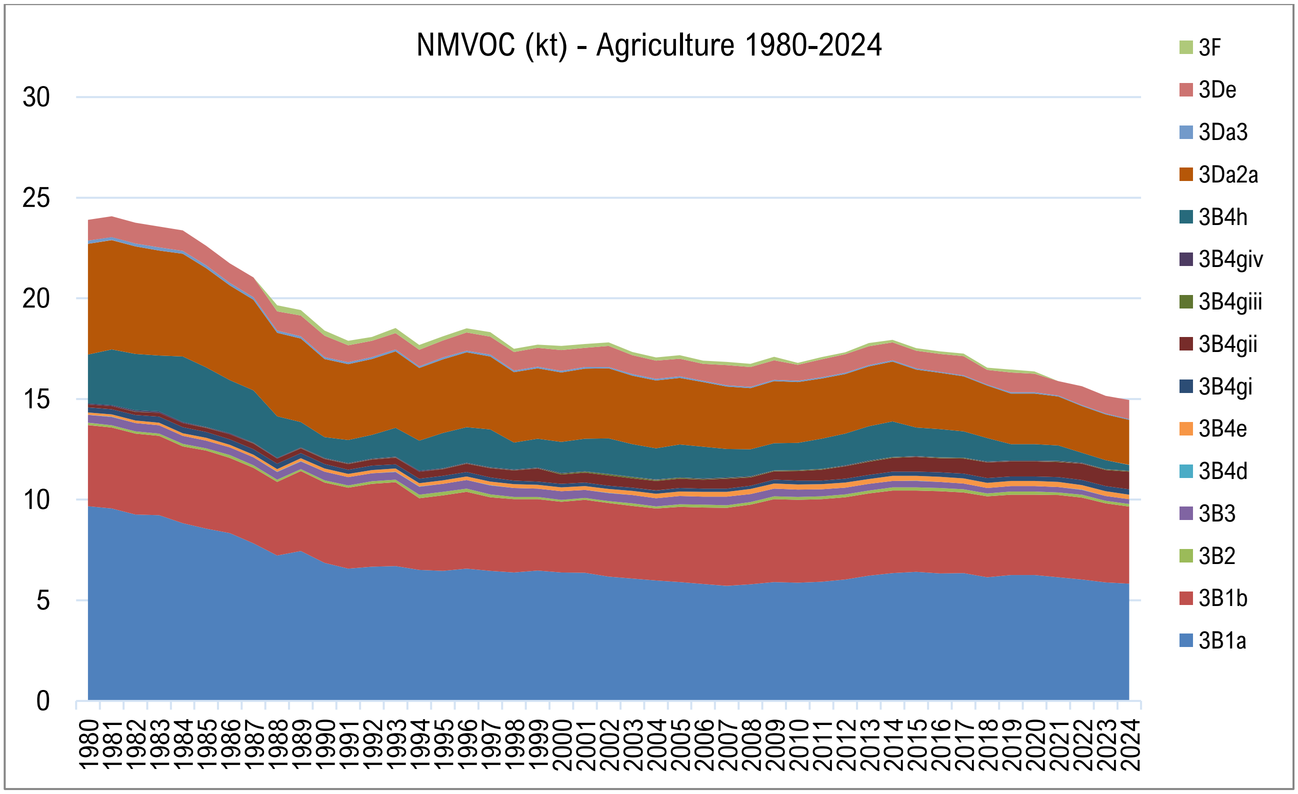


Figure 5.2. NMVOC emissions 1980-2024.

Table 5.3 NMVOC emissions from agricultural sources (Gg) 1980-2024.

Year	NFR 3B	NFR 3Da2a	NFR 3Da3	NFR 3De	NFR 3F*	Total
1980	17.21	5.49	0.16	1.03	NE	23.90
1981	17.46	5.43	0.16	1.03	NE	24.08
1982	17.23	5.34	0.15	1.03	NE	23.76
1983	17.16	5.22	0.15	1.03	NE	23.57
1984	17.11	5.10	0.15	1.01	NE	23.37
1985	16.58	4.93	0.14	0.97	NE	22.62
1986	15.93	4.71	0.14	0.96	NE	21.74
1987	15.42	4.50	0.13	0.98	NE	21.04
1988	14.15	4.14	0.12	0.95	0.30	19.36
1989	13.86	4.14	0.11	1.03	0.27	19.14
1990	13.10	3.89	0.10	1.062	0.25	18.15
1991	12.97	3.76	0.09	0.833	0.23	17.66
1992	13.22	3.77	0.09	0.817	0.19	17.90
1993	13.57	3.80	0.09	0.817	0.24	18.28
1994	12.94	3.60	0.09	0.824	0.23	17.45
1995	13.32	3.66	0.09	0.840	0.21	17.90
1996	13.61	3.71	0.09	0.898	0.22	18.30
1997	13.48	3.64	0.08	0.889	0.22	18.09
1998	12.84	3.49	0.08	0.928	0.15	17.34
1999	13.03	3.50	0.08	0.935	0.17	17.54
2000	12.87	3.45	0.08	1.034	0.21	17.43
2001	13.02	3.49	0.08	0.958	0.18	17.55
2002	13.04	3.47	0.07	1.052	0.17	17.64
2003	12.76	3.41	0.07	0.945	0.16	17.18
2004	12.56	3.37	0.07	0.904	0.16	16.90
2005	12.75	3.30	0.07	0.880	0.18	17.00
2006	12.62	3.21	0.07	0.841	0.16	16.75
2007	12.51	3.11	0.07	0.999	0.16	16.68
2008	12.50	3.04	0.06	0.977	0.17	16.58
2009	12.81	3.09	0.06	0.966	0.16	16.92
2010	12.82	3.02	0.06	0.794	0.10	16.69
2011	13.02	3.00	0.06	0.887	0.11	16.97
2012	13.28	2.96	0.06	0.915	0.11	17.22
2013	13.65	2.98	0.06	0.938	0.16	17.62
2014	13.89	2.97	0.06	0.890	0.14	17.81
2015	13.59	2.87	0.06	0.875	0.12	17.39
2016	13.51	2.79	0.06	0.895	0.12	17.24
2017	13.40	2.72	0.05	0.960	0.12	17.13
2018	13.06	2.60	0.05	0.732	0.11	16.45
2019	12.76	2.52	0.05	0.995	0.13	16.32
2020	12.76	2.52	0.05	0.932	0.11	16.26
2021	12.69	2.44	0.05	0.71	NO	15.89
2022	12.32	2.32	0.05	0.94	NO	15.63
2023	11.97	2.27	0.05	0.88	NO	15.16
2024	11.73	2.23	0.05	0.94	NO	14.95

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

NO_x

NO_x emissions are generated in manure management, use of fertilizers, manure, sewage sludge and other organic fertilisers applied to soils, deposits during grazing and field burning of agricultural residues. A summary of agricultural emissions is presented in Figure 5.3 and in Table 5.4.

The decreasing trend in NO_x emissions from agriculture is mainly a result of decreased use of mineral fertilisers (see Table 5.26) and decreasing trend in emissions from manure application.

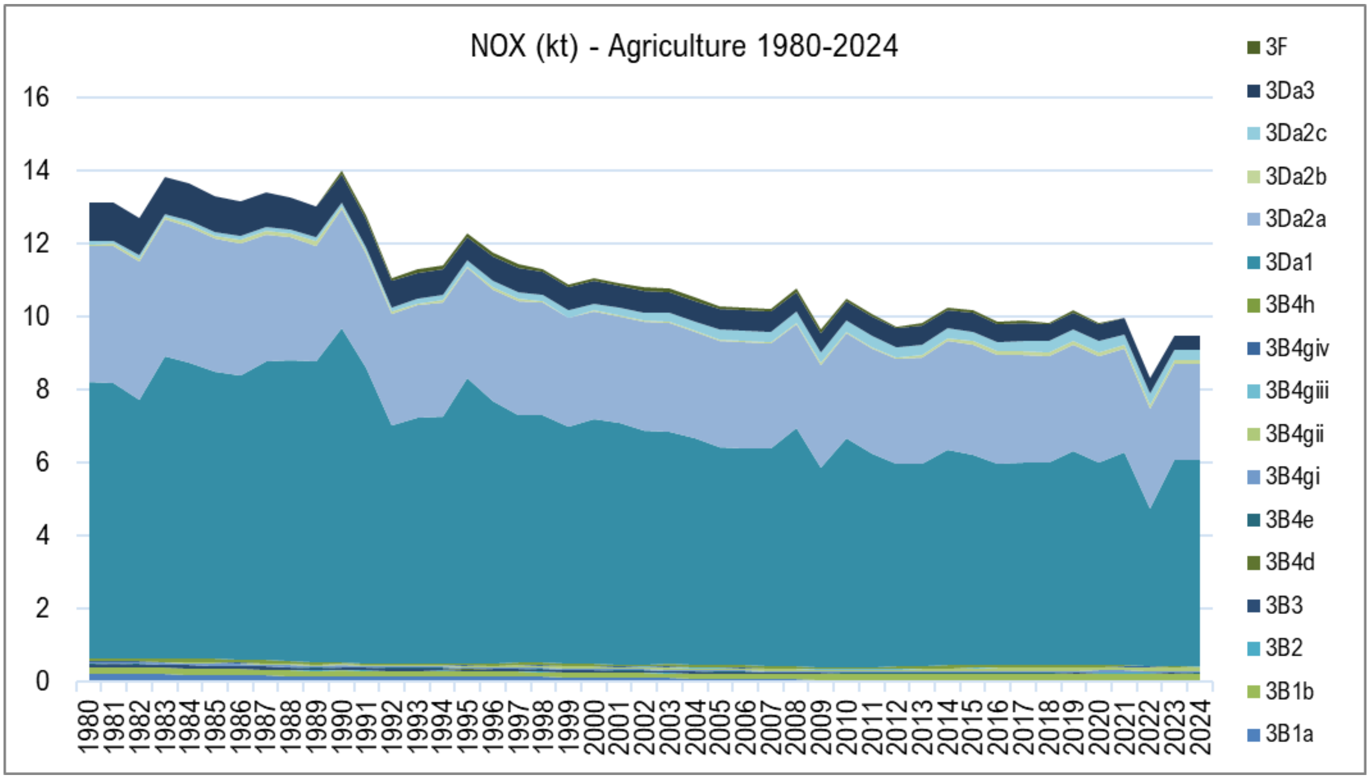


Figure 5.3. NO_x emissions 1980-2024.

Table 5.4. NO_x emissions from agricultural sources (Gg) 1980-2024.

Year	NFR 3B	NFR 3Da1	NFR 3Da2a	3Da2b	NFR 3Da3	NFR 3Da2c	NFR 3F*	Total
1980	0.64	7.57	3.74	0.05	1.05	0.09	NA	13.37
1981	0.64	7.54	3.78	0.06	1.05	0.09	NA	13.38
1982	0.65	7.09	3.79	0.06	1.04	0.09	NA	12.94
1983	0.65	8.27	3.74	0.07	1.02	0.09	NA	14.07
1984	0.64	8.12	3.71	0.08	1.02	0.09	NA	13.87
1985	0.64	7.85	3.66	0.08	0.98	0.10	NA	13.51
1986	0.63	7.78	3.60	0.10	0.96	0.10	NA	13.38
1987	0.60	8.17	3.49	0.11	0.94	0.10	NA	13.61
1988	0.59	8.23	3.37	0.10	0.90	0.10	NA	13.49
1989	0.54	8.24	3.18	0.11	0.87	0.10	NA	13.25
1990	0.54	9.14	3.27	0.06	0.78	0.10	NA	14.11
1991	0.52	8.10	3.13	0.06	0.75	0.12	NA	12.91
1992	0.51	6.53	3.05	0.05	0.71	0.13	NA	11.24
1993	0.51	6.73	3.07	0.05	0.71	0.14	NA	11.47
1994	0.52	6.77	3.11	0.06	0.69	0.15	NA	11.56
1995	0.51	7.82	3.00	0.05	0.65	0.17	NA	12.42
1996	0.52	7.18	3.06	0.06	0.66	0.19	NA	11.87
1997	0.53	6.78	3.13	0.08	0.65	0.18	NA	11.54
1998	0.53	6.80	3.07	0.03	0.63	0.19	NA	11.45
1999	0.49	6.51	2.95	0.03	0.61	0.20	NA	11.01
2000	0.50	6.69	2.95	0.03	0.61	0.20	NA	11.18
2001	0.48	6.63	2.91	0.03	0.59	0.21	NA	11.04
2002	0.48	6.42	2.96	0.03	0.60	0.23	NA	10.90
2003	0.49	6.37	2.99	0.03	0.58	0.23	NA	10.88
2004	0.47	6.19	2.94	0.03	0.58	0.24	NA	10.63
2005	0.46	5.99	2.91	0.03	0.57	0.27	NA	10.42
2006	0.45	5.93	2.93	0.03	0.57	0.28	NA	10.38
2007	0.44	5.95	2.88	0.04	0.55	0.29	NA	10.36
2008	0.44	6.52	2.86	0.04	0.55	0.29	NA	10.88
2009	0.41	5.44	2.84	0.05	0.55	0.28	NA	9.76
2010	0.41	6.26	2.87	0.05	0.55	0.30	NA	10.65
2011	0.42	5.85	2.86	0.06	0.54	0.30	NA	10.22
2012	0.42	5.56	2.86	0.06	0.52	0.27	NA	9.88
2013	0.44	5.53	2.93	0.07	0.51	0.27	NA	9.95
2014	0.46	5.90	2.99	0.08	0.51	0.27	NA	10.39
2015	0.47	5.74	3.04	0.08	0.50	0.27	NA	10.46
2016	0.46	5.53	2.97	0.10	0.49	0.24	NA	10.08
2017	0.46	5.56	2.94	0.11	0.48	0.27	NA	10.10
2018	0.47	5.54	2.92	0.10	0.47	0.30	NA	10.07
2019	0.47	5.87	2.89	0.11	0.46	0.31	NA	10.40
2020	0.45	5.58	2.90	0.10	0.46	0.30	NA	10.09
2021	0.46	5.84	2.85	0.11	0.44	0.29	NA	10.27
2022	0.44	4.32	2.73	0.11	0.43	0.29	NA	8.63
2023	0.43	5.64	2.66	0.10	0.41	0.26	NA	9.90
2024	0.44	5.64	2.63	0.10	0.41	0.28	NA	9.91

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

CO, SO_x

Emissions presented in Figure 5.4 and in Table 5.5 originate from field burning of agricultural residues (see NFR 3F). The CO and SO_x emission trends depend on the volume of annually burned biomass, which is calculated using different grain species and specific emission factors. Field burning of agricultural residues has been banned in Finland since the beginning of 2021.

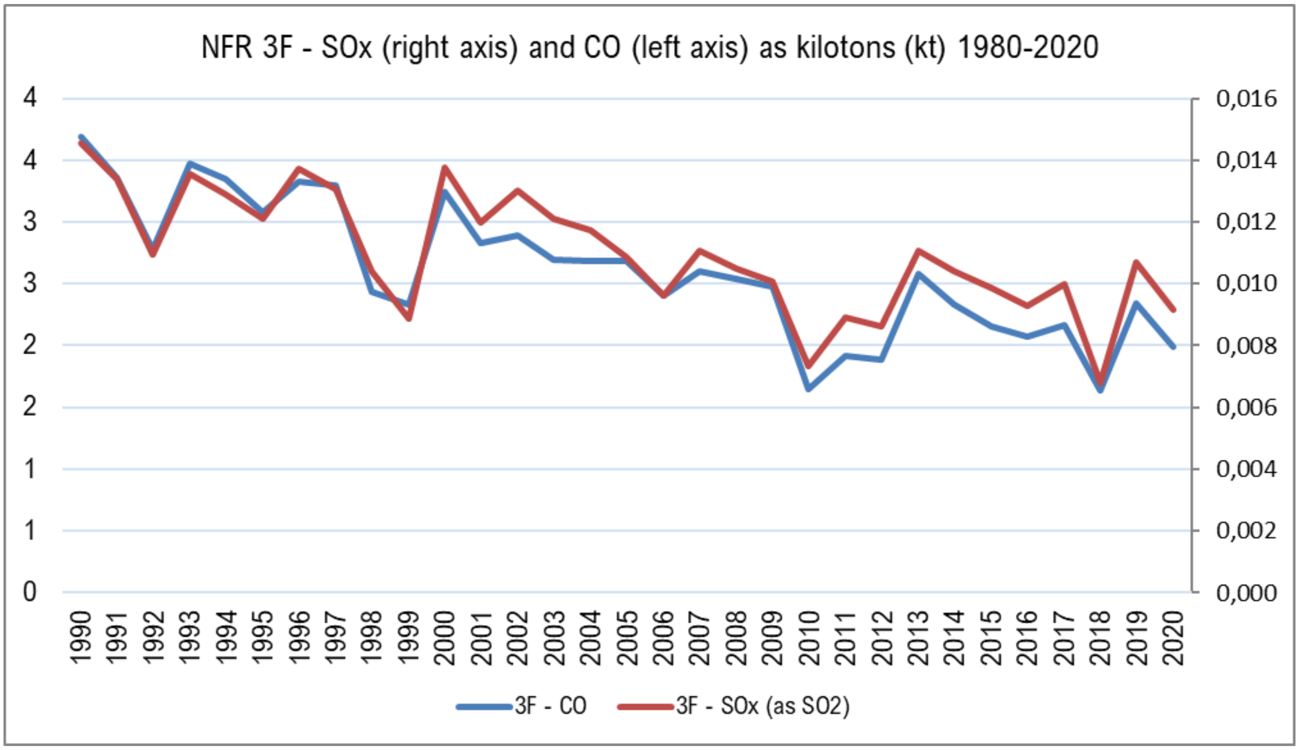


Figure 5.4. CO and SO_x emissions 1980-2020. Field burning of agricultural residues has been banned in Finland since the beginning of 2021.

Table 5.5 CO and SO_x emissions from field burning of agricultural residues (wheat and other grain) in 1990-2020. Field burning of agricultural residues has been banned in Finland since 1.1.2021.

Year	CO, NFR 3F*	SOx, NFR 3F*	Year	CO, NFR 3F*	SOx, NFR 3F*
1990	3.69	0.015	2010	1.65	0.007
1991	3.36	0.013	2011	1.91	0.009
1992	2.78	0.011	2012	1.88	0.009
1993	3.47	0.014	2013	2.58	0.011
1994	3.34	0.013	2014	2.33	0.010
1995	3.08	0.012	2015	2.16	0.010
1996	3.33	0.014	2016	2.08	0.009
1997	3.30	0.013	2017	2.16	0.010
1998	2.43	0.010	2018	1.63	0.007
1999	2.33	0.009	2019	2.34	0.011
2000	3.25	0.014	2020	1.99	0.009
2001	2.83	0.012	2021	NO	NO
2002	2.89	0.013	2022	NO	NO
2003	2.70	0.012	2023	NO	NO
2004	2.69	0.012	2024	NO	NO

Year	CO, NFR 3F*	SOx, NFR 3F*	Year	CO, NFR 3F*	SOx, NFR 3F*
2005	2.69	0.011			
2006	2.40	0.010			
2007	2.60	0.011			
2008	2.54	0.010			
2009	2.48	0.010			

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

Particles

TSP, PM_{10}, $PM_{2.5}$ and BC emissions (Figure 5.5) are generated in livestock husbandry, grain fields, storage and handling of agricultural crops as well as from field burning of agricultural residues as presented in Tables 5.6a-c. The fluctuation in emissions mainly reflects the fluctuations in harvested areas of different crops.

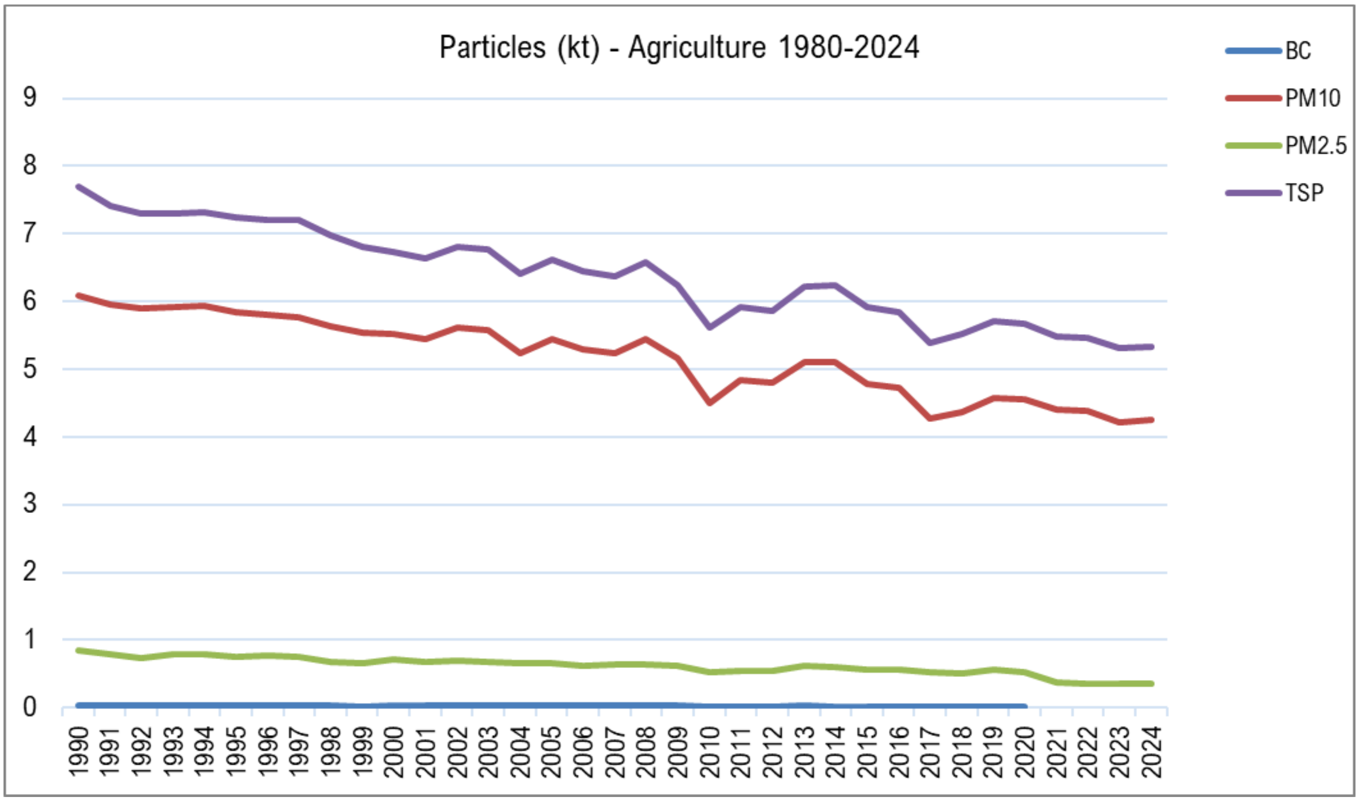


Figure 5.5. Particle emissions 1980-2024.

TSP (kt)	3B1a	3B1b	3B2	3B3	3B4d	3B4e	3B4gi	3B4gii	3B4giii	3B4giv	3B4h	3Dc	3F*
1990	0.66	0.30	0.01	0.54	0.00	0.01	0.53	0.04	0.00	0.23	0.11	5.08	0.31
1991	0.64	0.31	0.01	0.56	0.00	0.01	0.51	0.04	0.00	0.17	0.12	5.06	0.28
1992	0.62	0.31	0.01	0.56	0.00	0.01	0.57	0.04	0.00	0.17	0.13	5.05	0.23
1993	0.60	0.30	0.01	0.55	0.00	0.01	0.59	0.04	0.00	0.23	0.13	5.03	0.29
1994	0.59	0.30	0.01	0.51	0.00	0.01	0.77	0.05	0.00	0.22	0.13	5.02	0.28
1995	0.56	0.29	0.01	0.47	0.00	0.01	0.81	0.05	0.00	0.19	0.16	5.00	0.25
1996	0.53	0.29	0.01	0.48	0.00	0.01	0.82	0.06	0.00	0.19	0.14	4.97	0.28
1997	0.51	0.27	0.01	0.49	0.00	0.01	0.84	0.07	0.00	0.19	0.13	4.95	0.27
1998	0.48	0.27	0.01	0.47	0.00	0.01	0.87	0.08	0.00	0.20	0.12	4.94	0.20
1999	0.44	0.25	0.01	0.46	0.00	0.01	0.87	0.07	0.00	0.20	0.10	4.91	0.19
2000	0.45	0.26	0.01	0.52	0.00	0.01	0.90	0.06	0.00	0.23	0.06	4.90	0.27
2001	0.41	0.26	0.01	0.49	0.00	0.01	0.76	0.07	0.00	0.19	0.05	4.89	0.23
2002	0.39	0.26	0.01	0.46	0.00	0.01	0.73	0.07	0.00	0.23	0.05	4.84	0.24
2003	0.39	0.25	0.01	0.44	0.00	0.01	0.74	0.08	0.00	0.22	0.06	4.82	0.22
2004	0.38	0.25	0.01	0.43	0.00	0.01	0.75	0.08	0.00	0.21	0.07	4.86	0.22
2005	0.36	0.22	0.01	0.44	0.00	0.01	0.77	0.09	0.00	0.21	0.07	4.80	0.22
2006	0.36	0.22	0.01	0.45	0.00	0.01	0.77	0.09	0.01	0.18	0.08	4.76	0.20
2007	0.35	0.22	0.01	0.48	0.00	0.01	0.76	0.10	0.01	0.18	0.08	4.71	0.22
2008	0.34	0.22	0.01	0.44	0.00	0.01	0.70	0.12	0.01	0.17	0.09	4.67	0.21
2009	0.33	0.21	0.01	0.44	0.00	0.01	0.62	0.13	0.01	0.15	0.06	4.65	0.21
2010	0.32	0.21	0.01	0.42	0.00	0.01	0.57	0.17	0.01	0.13	0.07	4.55	0.14
2011	0.31	0.20	0.01	0.40	0.00	0.02	0.59	0.12	0.03	0.15	0.07	4.52	0.16
2012	0.29	0.20	0.01	0.41	0.00	0.02	0.59	0.12	0.03	0.11	0.08	4.71	0.16
2013	0.28	0.20	0.01	0.43	0.00	0.02	0.55	0.13	0.03	0.13	0.08	4.68	0.21
2014	0.26	0.19	0.01	0.43	0.00	0.02	0.56	0.12	0.03	0.13	0.08	4.36	0.19
2015	0.25	0.19	0.00	0.44	0.00	0.02	0.57	0.12	0.03	0.13	0.07	4.57	0.18
2016	0.25	0.19	0.01	0.43	0.00	0.02	0.56	0.12	0.03	0.12	0.08	4.46	0.17
2017	0.24	0.19	0.01	0.44	0.00	0.02	0.55	0.11	0.02	0.10	0.08	4.41	0.18
2018	0.23	0.18	0.01	0.43	0.00	0.02	0.55	0.12	0.02	0.11	0.07	4.62	0.14
2019	0.23	0.18	0.01	0.42	0.00	0.02	0.50	0.10	0.02	0.11	0.06	4.38	0.20
2020	0.23	0.18	0.01	0.40	0.00	0.02	0.57	0.10	0.02	0.10	0.06	3.79	0.17
2021	0.23	0.18	0.01	0.39	0.00	0.02	0.54	0.12	0.02	0.09	0.06	4.11	NO
2022	0.23	0.17	0.01	0.38	0.00	0.02	0.51	0.13	0.02	0.09	0.07	4.08	NO
2023	0.23	0.18	0.01	0.37	0.00	0.02	0.56	0.15	0.02	0.10	0.08	4.31	NO
2024	0.23	0.18	0.01	0.36	0.00	0.02	0.60	0.16	0.02	0.09	0.08	4.31	NO

Table 5.6a TSP emissions (kt) by NFR category 1990-2024.

* *Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

Table 5.6b $PM_{2.5}$ emissions (kt) by NFR 1990-2024.

$PM_{2.5}$ kt	3B1a	3B1b	3B2	3B3	3B4d	3B4e	3B4gi	3B4gii	3B4giii	3B4giv	3B4h	3Dc	3F*
1990	0.132	0.079	0.001	0.004	0.000	0.004	0.014	0.003	0.001	0.032	0.013	0.268	0.29
1991	0.120	0.078	0.001	0.004	0.000	0.004	0.012	0.003	0.001	0.026	0.011	0.268	0.26
1992	0.116	0.077	0.001	0.004	0.000	0.004	0.012	0.004	0.001	0.032	0.012	0.265	0.22
1993	0.116	0.075	0.001	0.004	0.000	0.004	0.012	0.004	0.001	0.030	0.012	0.264	0.27
1994	0.113	0.074	0.001	0.003	0.000	0.004	0.012	0.004	0.001	0.029	0.015	0.266	0.26
1995	0.108	0.066	0.001	0.004	0.000	0.004	0.012	0.005	0.001	0.030	0.016	0.263	0.24
1996	0.106	0.067	0.001	0.004	0.000	0.004	0.012	0.004	0.001	0.025	0.019	0.261	0.26
1997	0.105	0.067	0.001	0.004	0.000	0.004	0.012	0.005	0.001	0.025	0.019	0.258	0.26
1998	0.102	0.065	0.001	0.004	0.000	0.004	0.011	0.006	0.001	0.024	0.020	0.256	0.19
1999	0.098	0.064	0.001	0.004	0.000	0.004	0.010	0.006	0.002	0.020	0.014	0.255	0.18
2000	0.095	0.062	0.001	0.004	0.000	0.004	0.009	0.008	0.002	0.018	0.015	0.249	0.25
2001	0.091	0.061	0.001	0.003	0.000	0.004	0.009	0.006	0.005	0.021	0.016	0.248	0.22
2002	0.088	0.061	0.001	0.003	0.000	0.005	0.009	0.006	0.005	0.016	0.017	0.259	0.23
2003	0.082	0.060	0.001	0.004	0.000	0.005	0.009	0.006	0.006	0.019	0.019	0.257	0.21
2004	0.078	0.058	0.001	0.003	0.000	0.005	0.009	0.006	0.005	0.018	0.017	0.240	0.21
2005	0.075	0.057	0.001	0.004	0.000	0.006	0.009	0.006	0.005	0.019	0.016	0.251	0.21
2006	0.073	0.057	0.001	0.003	0.000	0.006	0.009	0.006	0.005	0.016	0.017	0.245	0.19
2007	0.070	0.056	0.001	0.004	0.000	0.006	0.009	0.005	0.004	0.015	0.017	0.242	0.20
2008	0.069	0.055	0.001	0.003	0.000	0.006	0.009	0.006	0.004	0.016	0.015	0.254	0.20
2009	0.069	0.054	0.001	0.003	0.000	0.006	0.008	0.005	0.003	0.015	0.014	0.241	0.19
2010	0.069	0.055	0.001	0.003	0.000	0.006	0.009	0.005	0.003	0.014	0.014	0.209	0.13
2011	0.068	0.053	0.001	0.003	0.000	0.006	0.009	0.006	0.003	0.013	0.014	0.227	0.15
2012	0.068	0.053	0.001	0.003	0.000	0.006	0.008	0.007	0.003	0.012	0.016	0.225	0.15
2013	0.067	0.053	0.001	0.003	0.000	0.006	0.009	0.007	0.003	0.014	0.017	0.237	0.20
2014	0.067	0.053	0.001	0.003	0.000	0.006	0.009	0.008	0.003	0.012	0.018	0.238	0.18
2015	0.066	0.053	0.001	0.003	0.000	0.006	0.009	0.008	0.002	0.011	0.019	0.222	0.17
2016	0.065	0.052	0.001	0.002	0.000	0.006	0.009	0.009	0.003	0.012	0.015	0.219	0.16
2017	0.063	0.052	0.001	0.002	0.000	0.006	0.010	0.009	0.003	0.009	0.015	0.195	0.17
2018	0.061	0.051	0.001	0.002	0.000	0.006	0.011	0.009	0.003	0.010	0.014	0.202	0.13
2019	0.059	0.050	0.001	0.002	0.000	0.006	0.011	0.010	0.003	0.011	0.012	0.210	0.18
2020	0.058	0.049	0.001	0.002	0.000	0.006	0.010	0.009	0.003	0.009	0.009	0.213	0.16
2021	0.06	0.05	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.21	NO
2022	0.05	0.05	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.21	NO
2023	0.05	0.05	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.20	NO
2024	0.05	0.05	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.21	NO

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

PM$_{10}$ kt	3B1a	3B1b	3B2	3B3	3B4d	3B4e	3B4gi	3B4gii	3B4giii	3B4giv	3B4h	3Dc	3F*
1990	0.20	0.12	0.00	0.09	0.00	0.01	0.19	0.03	0.00	0.23	0.03	4.90	0.30
1991	0.19	0.12	0.00	0.08	0.00	0.01	0.16	0.03	0.00	0.18	0.02	4.89	0.27
1992	0.18	0.12	0.00	0.08	0.00	0.01	0.15	0.04	0.00	0.22	0.02	4.84	0.23
1993	0.18	0.12	0.00	0.07	0.00	0.01	0.16	0.04	0.00	0.21	0.02	4.82	0.28
1994	0.17	0.11	0.00	0.07	0.00	0.01	0.16	0.04	0.00	0.20	0.03	4.86	0.27
1995	0.17	0.10	0.00	0.07	0.00	0.01	0.16	0.05	0.00	0.21	0.03	4.80	0.25
1996	0.16	0.10	0.00	0.08	0.00	0.01	0.16	0.04	0.01	0.18	0.04	4.76	0.27
1997	0.16	0.10	0.00	0.08	0.00	0.01	0.16	0.05	0.01	0.18	0.04	4.71	0.27
1998	0.16	0.10	0.00	0.08	0.00	0.01	0.15	0.06	0.01	0.17	0.04	4.67	0.20
1999	0.15	0.10	0.00	0.07	0.00	0.01	0.13	0.06	0.01	0.14	0.03	4.65	0.19
2000	0.15	0.10	0.00	0.07	0.00	0.01	0.12	0.08	0.01	0.13	0.03	4.55	0.27
2001	0.14	0.09	0.00	0.07	0.00	0.01	0.12	0.06	0.03	0.15	0.03	4.52	0.23
2002	0.13	0.09	0.00	0.07	0.00	0.01	0.12	0.06	0.03	0.11	0.03	4.71	0.24
2003	0.13	0.09	0.00	0.07	0.00	0.01	0.12	0.06	0.03	0.13	0.04	4.68	0.22
2004	0.12	0.09	0.00	0.07	0.00	0.01	0.12	0.06	0.03	0.13	0.03	4.36	0.22
2005	0.12	0.09	0.00	0.07	0.00	0.01	0.12	0.06	0.03	0.13	0.03	4.57	0.22
2006	0.11	0.09	0.00	0.07	0.00	0.01	0.12	0.06	0.03	0.11	0.03	4.46	0.20
2007	0.11	0.09	0.00	0.07	0.00	0.01	0.12	0.05	0.02	0.10	0.03	4.41	0.21
2008	0.11	0.08	0.00	0.07	0.00	0.01	0.12	0.06	0.02	0.11	0.03	4.62	0.21
2009	0.11	0.08	0.00	0.07	0.00	0.01	0.10	0.05	0.02	0.11	0.03	4.38	0.20
2010	0.11	0.08	0.00	0.06	0.00	0.01	0.12	0.05	0.02	0.10	0.03	3.79	0.14
2011	0.10	0.08	0.00	0.06	0.00	0.01	0.11	0.06	0.02	0.09	0.03	4.11	0.16
2012	0.10	0.08	0.00	0.06	0.00	0.01	0.11	0.07	0.02	0.09	0.03	4.08	0.15
2013	0.10	0.08	0.00	0.06	0.00	0.01	0.12	0.07	0.02	0.10	0.03	4.31	0.21
2014	0.10	0.08	0.00	0.06	0.00	0.01	0.13	0.08	0.02	0.08	0.04	4.31	0.19
2015	0.10	0.08	0.00	0.06	0.00	0.01	0.12	0.08	0.01	0.08	0.04	4.01	0.18
2016	0.10	0.08	0.00	0.05	0.00	0.01	0.13	0.09	0.01	0.09	0.03	3.97	0.17
2017	0.10	0.08	0.00	0.05	0.00	0.01	0.13	0.09	0.02	0.06	0.03	3.52	0.18
2018	0.09	0.08	0.00	0.05	0.00	0.01	0.14	0.09	0.02	0.07	0.03	3.66	0.13
2019	0.09	0.08	0.00	0.05	0.00	0.01	0.14	0.10	0.01	0.08	0.02	3.80	0.19
2020	0.09	0.08	0.00	0.05	0.00	0.01	0.14	0.09	0.01	0.07	0.02	3.85	0.16
2021	0.09	0.08	0.00	0.04	0.00	0.01	0.14	0.09	0.02	0.09	0.02	3.84	NO
2022	0.08	0.08	0.00	0.04	0.00	0.01	0.14	0.09	0.02	0.08	0.01	3.84	NO
2023	0.08	0.07	0.00	0.04	0.00	0.01	0.15	0.09	0.02	0.07	0.01	3.68	NO
2024	0.08	0.07	0.00	0.04	0.00	0.01	0.15	0.10	0.02	0.06	0.01	3.71	NO

Table 5.6c PM$_{10}$ emissions (kt) by NFR 1990-2024.

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

Heavy metals

Emissions are generated in field burning of agricultural residues as described under NFR 3F.

The emission trends presented in Figure 5.6 and Table 5.7 are impacted by the volume of field burning of straw which has a declining trend.

Field burning of agricultural residues has been banned in Finland since the beginning of 2021, resulting zero emissions for 2021 and beyond.

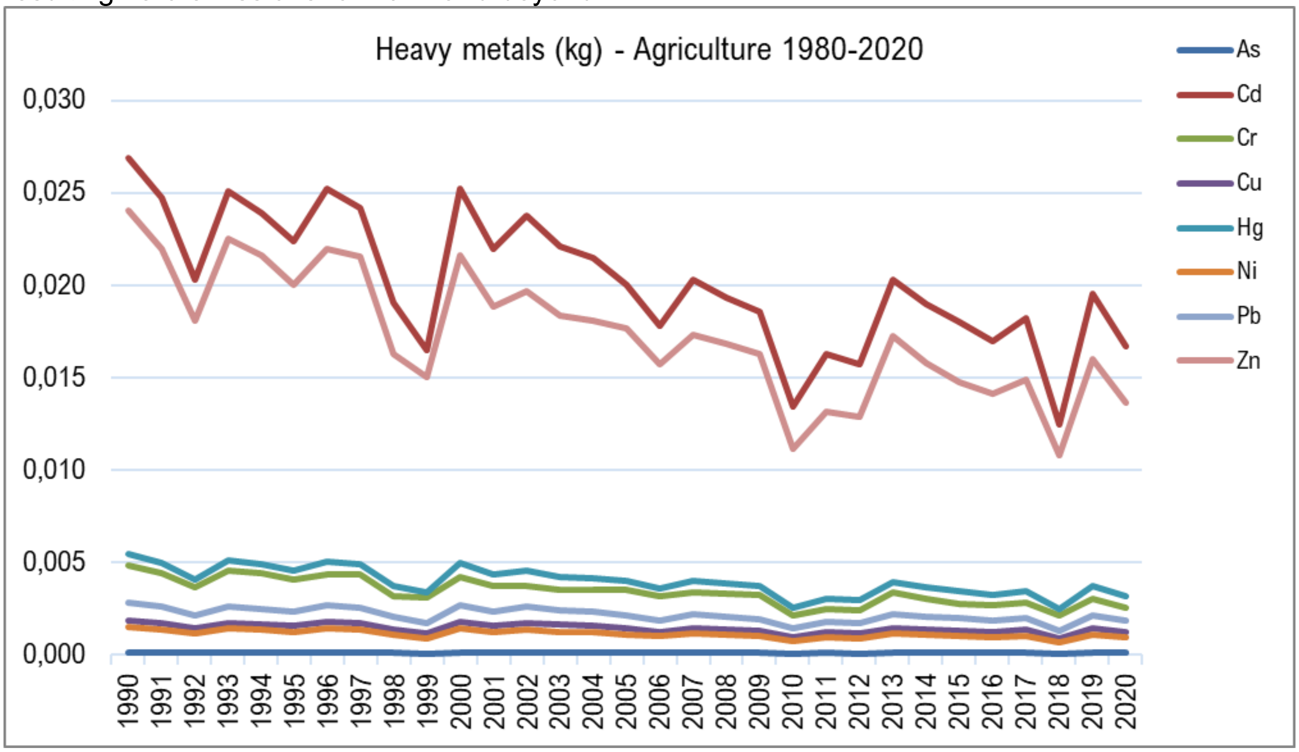


Figure 5.6 Heavy metals from agriculture 1980-2020. Field burning of agricultural residues has been banned in Finland since the beginning of 2021.

Table 5.7 Heavy metal emissions (t) from field burning of agricultural residues NFR 3F 1990-2024

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1980	NE	NE	NE	NE	NE	NE	NE	NE	NE
1981	NE	NE	NE	NE	NE	NE	NE	NE	NE
1982	NE	NE	NE	NE	NE	NE	NE	NE	NE
1983	NE	NE	NE	NE	NE	NE	NE	NE	NE
1984	NE	NE	NE	NE	NE	NE	NE	NE	NE
1985	NE	NE	NE	NE	NE	NE	NE	NE	NE
1986	NE	NE	NE	NE	NE	NE	NE	NE	NE
1987	NE	NE	NE	NE	NE	NE	NE	NE	NE
1988	NE	NE	NE	NE	NE	NE	NE	NE	NE
1989	NE	NE	NE	NE	NE	NE	NE	NE	NE
1990	0.003	0.027	0.005	0.000	0.005	0.002	0.002	0.001	0.024
1991	0.003	0.025	0.005	0.000	0.004	0.002	0.001	0.001	0.022
1992	0.002	0.020	0.004	0.000	0.004	0.001	0.001	0.001	0.018
1993	0.003	0.025	0.005	0.000	0.005	0.002	0.001	0.001	0.023
1994	0.002	0.024	0.005	0.000	0.004	0.002	0.001	0.001	0.022
1995	0.002	0.022	0.005	0.000	0.004	0.002	0.001	0.001	0.020
1996	0.003	0.025	0.005	0.000	0.004	0.002	0.001	0.001	0.022
1997	0.003	0.024	0.005	0.000	0.004	0.002	0.001	0.001	0.022
1998	0.002	0.019	0.004	0.000	0.003	0.001	0.001	0.001	0.016
1999	0.002	0.016	0.003	0.000	0.003	0.001	0.001	0.001	0.015
2000	0.003	0.025	0.005	0.000	0.004	0.002	0.001	0.001	0.022
2001	0.002	0.022	0.004	0.000	0.004	0.002	0.001	0.001	0.019
2002	0.003	0.024	0.005	0.000	0.004	0.002	0.001	0.001	0.020
2003	0.002	0.022	0.004	0.000	0.004	0.002	0.001	0.001	0.018
2004	0.002	0.022	0.004	0.000	0.004	0.002	0.001	0.001	0.018
2005	0.002	0.020	0.004	0.000	0.004	0.001	0.001	0.001	0.018
2006	0.002	0.018	0.004	0.000	0.003	0.001	0.001	0.001	0.016
2007	0.002	0.020	0.004	0.000	0.003	0.001	0.001	0.001	0.017
2008	0.002	0.019	0.004	0.000	0.003	0.001	0.001	0.001	0.017
2009	0.002	0.019	0.004	0.000	0.003	0.001	0.001	0.001	0.016
2010	0.001	0.013	0.003	0.000	0.002	0.001	0.001	0.001	0.011
2011	0.002	0.016	0.003	0.000	0.002	0.001	0.001	0.001	0.013
2012	0.002	0.016	0.003	0.000	0.002	0.001	0.001	0.001	0.013
2013	0.002	0.020	0.004	0.000	0.003	0.001	0.001	0.001	0.017
2014	0.002	0.019	0.004	0.000	0.003	0.001	0.001	0.001	0.016
2015	0.002	0.018	0.003	0.000	0.003	0.001	0.001	0.001	0.015
2016	0.002	0.017	0.003	0.000	0.003	0.001	0.001	0.001	0.014
2017	0.002	0.018	0.003	0.000	0.003	0.001	0.001	0.001	0.015
2018	0.001	0.012	0.002	0.000	0.002	0.001	0.001	0.001	0.011
2019	0.002	0.020	0.004	0.000	0.003	0.001	0.001	0.001	0.016
2020	0.002	0.017	0.003	0.000	0.003	0.001	0.001	0.001	0.014
2021	NO	NO	NO	NO	NO	NO	NO	NO	NO
2022	NO	NO	NO	NO	NO	NO	NO	NO	NO
2023	NO	NO	NO	NO	NO	NO	NO	NO	NO
2024	NO	NO	NO	NO	NO	NO	NO	NO	NO

POPs

HCB emissions originate from the use of pesticides while PAH emissions originate from field burning of agricultural residues (NFR 3F) (Figure 5.7).

PAH-4 emission trends presented in Figure 5.7 and Table 5.8 are impacted by the volume of field burning of straw and agricultural residues, which both have a declining trend.

Field burning of agricultural residues has been banned in Finland since the beginning of 2021, resulting zero emissions for 2021 and beyond.

The decrease in HCB emissions in early 2000s is due to the strong decrease in the use of Simazine, which was forbidden in 2004 in the EU, and the increase in 2011 is due to the replacement by a new herbicide which came into market (selling permit granted 12.4.2011). The sales of this new herbicide vary quite a lot between the years.

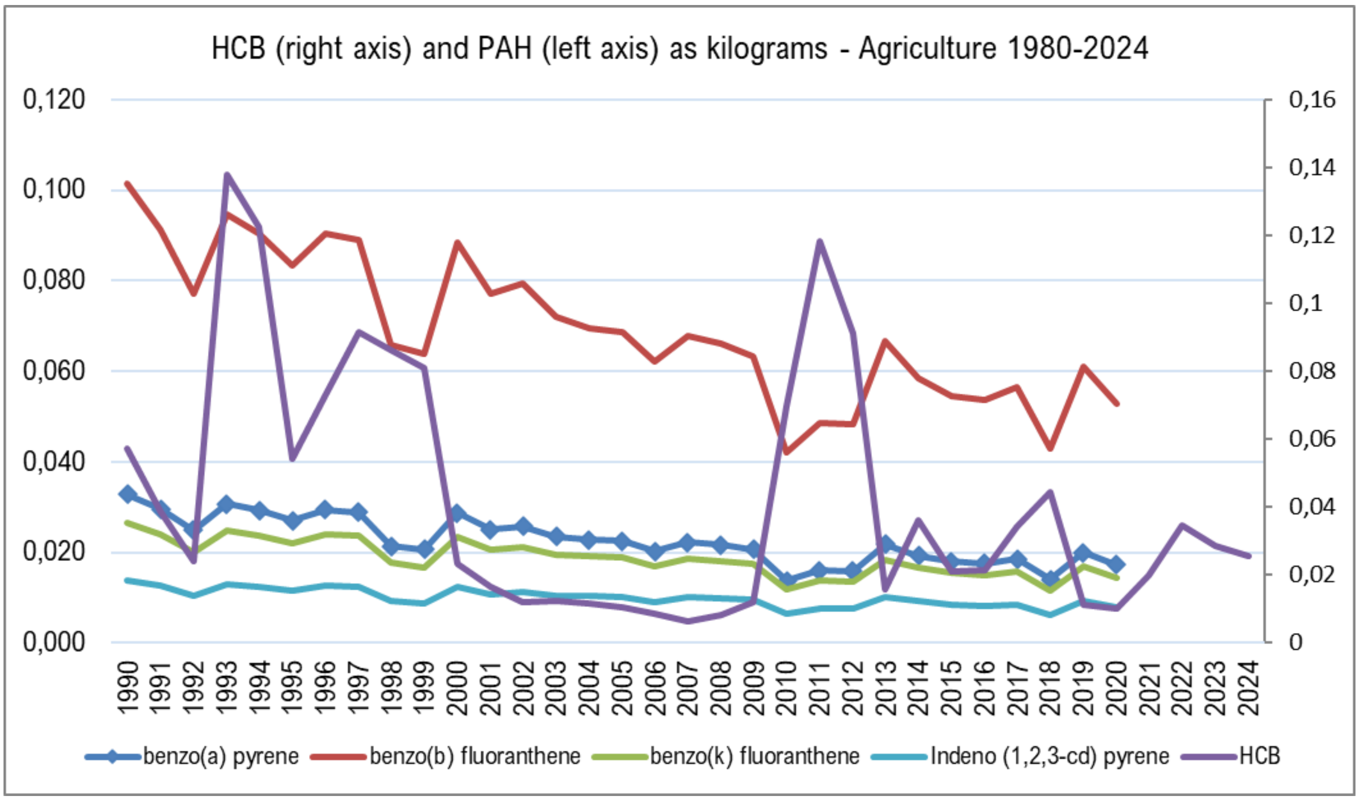


Figure 5.7. POP emissions from agricultural sources 1990-2024.

Table 5.8 POP emissions from agriculture 1990-2024.

Year	PCDD/F (3F)	HCB (3Df)	B(a)P (3F)	B(b)F (3F)	B(k)F (3F)	I(1,2,3-cdP) (3F)
	g I-Teq	kg	kg	kg	kg	kg
1990	NA	0.057	0.033	0.101	0.027	0.014
1991	NA	0.039	0.030	0.091	0.024	0.013
1992	NA	0.024	0.025	0.077	0.020	0.010
1993	NA	0.138	0.031	0.095	0.025	0.013
1994	NA	0.123	0.029	0.090	0.024	0.012
1995	NA	0.054	0.027	0.083	0.022	0.012
1996	NA	0.073	0.029	0.091	0.024	0.013
1997	NA	0.091	0.029	0.089	0.024	0.012
1998	NA	0.086	0.021	0.066	0.018	0.009
1999	NA	0.081	0.021	0.064	0.017	0.009
2000	NA	0.023	0.029	0.088	0.024	0.012
2001	NA	0.017	0.025	0.077	0.021	0.011
2002	NA	0.012	0.026	0.079	0.021	0.011
2003	NA	0.012	0.024	0.072	0.020	0.011
2004	NA	0.012	0.023	0.070	0.019	0.010
2005	NA	0.011	0.022	0.069	0.019	0.010
2006	NA	0.008	0.020	0.062	0.017	0.009
2007	NA	0.006	0.022	0.068	0.019	0.010
2008	NA	0.008	0.022	0.066	0.018	0.010
2009	NA	0.012	0.021	0.063	0.017	0.009
2010	NA	0.070	0.014	0.042	0.012	0.006
2011	NA	0.118	0.016	0.049	0.014	0.008
2012	NA	0.091	0.016	0.048	0.014	0.007
2013	NA	0.016	0.022	0.067	0.018	0.010
2014	NA	0.036	0.019	0.059	0.017	0.009
2015	NA	0.021	0.018	0.055	0.015	0.009
2016	NA	0.021	0.018	0.054	0.015	0.008
2017	NA	0.034	0.019	0.057	0.016	0.009
2018	NA	0.045	0.014	0.043	0.012	0.006
2019	NA	0.011	0.020	0.061	0.017	0.009
2020	NA	0.010	0.017	0.053	0.014	0.008
2021	NA	0.02	NO	NO	NO	NO
2022	NA	0.03	NO	NO	NO	NO
2023	NA	0.03	NO	NO	NO	NO
2024	NA	0.03	NO	NO	NO	NO

5.3 General methodological issues

The calculation of agricultural emissions includes the source categories and emissions presented in Table 5.9. Currently, the Finnish Agricultural Emissions Calculation System comprises four separate Calculation Modules:

1. a model for agricultural emissions (Module 1), covering emissions mainly from manure-related sources, as well as emissions from other organic fertilisers and mineral N fertilisers (NFR 3B, 3Da1, 3Da2a, 3Da2c, 3Da3). The model also includes the calculation of NH_3 emissions for the waste category “Biological treatment of waste – Anaerobic digestion at biogas facilities” (NFR 5B2),
2. a model for emissions from field operations (NFR 3Da4, 3Dc, 3De, 3F),
3. a model for emissions from sewage sludge applied to soils (NFR 3Da2b),
4. a model for emissions from the use of pesticides (NFR 3Df).

Table 5.9 Source categories and emissions included in the Finnish Agricultural Emissions Calculation System.

NFR	Category name	NH_3	NO_x	N_2O direct	N_2O indirect	N_2	NMVOC	PM
3B	Manure management (animal categories: see chapter 2.1.1.1)	x	x	x	x	x	x	x
3Da1	Inorganic N-fertilizers (also includes urea application)	x	x	x	x			
3Da2a	Livestock manure applied to soils	x	x	x	x		x	
3Da2b	Sewage sludge applied to soils	x	x					
3Da2c	Other organic fertilisers applied to soils	x	x					
3Da3	Urine and dung deposited by grazing livestock	x	x	x	x		x	
3Da4	Crop residues applied on soils	x						
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products							x
3De	Cultivated crops						x	

Additionally, the following source categories and emissions are included in the calculation system:

3Df	Use of pesticides	HCB emissions
3F	Field burning of agricultural residues*	NOx, CO, NMVOC, SOx, NH3, TSP, PM10 PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAH-4

** Field burning of agricultural residues has been banned in Finland since the beginning of 2021*

Documentation of the Finnish Agricultural Emission Calculation Model (calculation module 1) is presented below and in more detail in a separate document Grönroos et al 2017 (saved in the submission folder).

The whole Finnish Agricultural Emissions Calculation System is updated yearly, a new reporting year is added every year and the previous years are updated when new information is available.

Calculation model for agricultural emissions (Calculation Module 1)

Since 1998, emissions of ammonia and other gaseous nitrogen compounds originating from manure have been calculated by using the national nitrogen model, which is based on the nitrogen flow approach. In this approach, flow of total ammoniacal nitrogen (TAN) and total nitrogen (tot-N) are followed through the manure management system so that the more NH_3 and other nitrogen compounds are emitted at the previous stage of the manure management system the less TAN and tot-N remain available for emissions later. Besides manure management, the model also includes emission calculation from other manure related sources, from other organic fertilisers and from mineral N-fertilisers. The documentation of the previous calculation systems was published by Grönroos et al. in 1998 (in Finnish) and in 2009 (in English). Originally, the model was used only for ammonia and nitrous oxide emission calculation, but it was supplemented later with other nitrogen compounds.

The model was revised in 2016-2017 (Figure 5.8) and includes currently gaseous nitrogen emissions (N_2, NH_3, N_2O and NO) thus integrating the calculation of nitrogen emissions between the greenhouse gas and air pollutant emission inventories. It also enables reporting of emissions at the level of detail in the reporting guidelines of the UNECE CLRTAP and the UNFCCC.

The revision of the model included updating and expanding the model to meet the most recent requirements of the emission inventory guidelines of UNECE (EMEP/EEA 2023) and UNFCCC (IPCC 2006). The revision included change of the nitrogen flow approach to include also ammoniacal nitrogen (TAN) besides the total nitrogen. In the previous model version, the approach was mainly based on the total nitrogen.

During the model revision in 2016-2017, nitrogen from bedding materials was also included into the calculation. In addition to the ammonia (NH_3) and direct and indirect nitrous oxide (N_2O) emissions (originating from manure management and managed soils), emissions of nitric oxide (NO) and di-nitrogen (N_2) from manure management are calculated, as well as NO emissions from application of manure (incl. urine and dung deposited by grazing livestock), sewage sludge and other organic fertilisers, and mineral fertilisers.

NMVOC emission calculation for manure management, manure applied to soils, urine and dung deposited by grazing livestock and cultivated crops was added to the calculation system (see Table 5.9, and Chapter 3 in Grönroos et al., 2017). Further, the changes enabled the establishment of the Finnish normative manure system (see Luostarinen et al. 2017), which was built simultaneously with the revision of this model. Particle emissions from animal husbandry and field operations (cultivation, harvesting, cleaning, and drying) were added to the calculation system in 2019. Part of the NMVOC and PM emissions are calculated in Module 1 and part in Module 2.

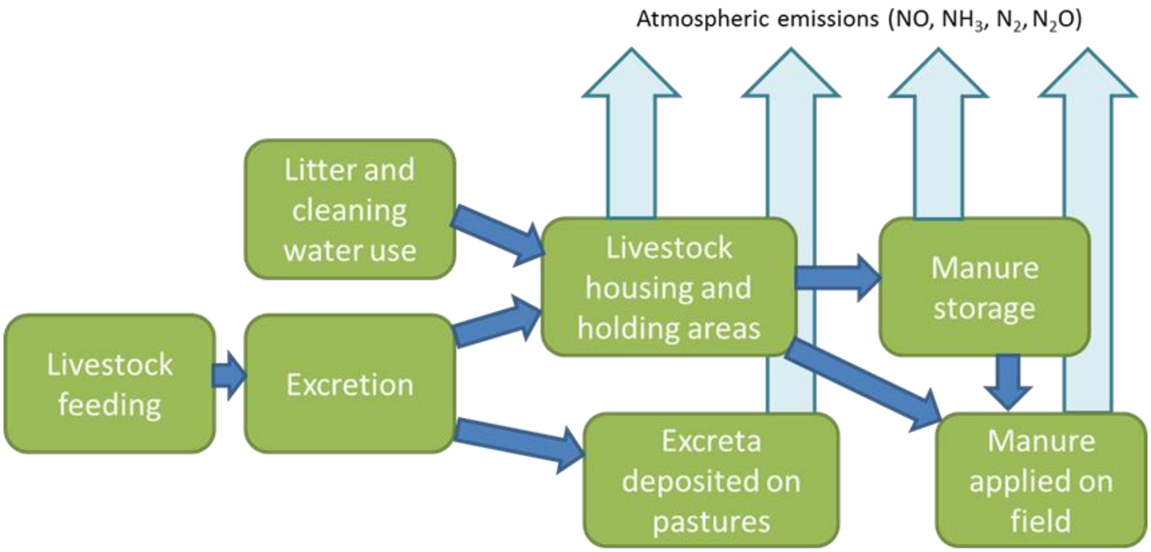


Figure 5.8 Manure-related emission calculation section in the calculation model for agriculture (Grönroos et al., 2017)

The agricultural emission calculation model is part of the Finnish normative manure system (Luostarinen et al. 2017). The normative manure system is used to calculate normative manure quality and quantity data for various livestock animal categories (Tables 5.10.a and 5.10.b), to be used e.g., in policymaking, research, technology development and manure fertilisation plans on farms. Major inputs from normative manure system to the agricultural emissions calculation model are nitrogen excretion rates for each animal category (divided between faeces and urine), and effects of the nitrogen transformation processes to quantity of TAN in a manure management system.

Table 5.10.a. Animal categories considered in the emission calculation model; the detailed categorisation. The animal categories are the same as those in the Finnish normative manure system (Luostarinen et al. 2017).

CATTLE	PIGS	POULTRY	OTHER ANIMALS
Dairy cow, high yielding	Farrowing sow + piglets (<10-12 kg)	Laying hen breeder	Horse
Dairy cow, indigenous	Gestating sow	Cockerel (laying hen breeder, male)	
	Mating sow	Broiler	Pony (120-140)
Suckler cow, high yielding	Boar (50- kg)	Broiler breeder hen	Pony, little (<120)
Suckler cow, indigenous	Fattening pig (50- kg)	Broiler breeder, male	
		Laying hen pullet	Ewe
Heifer, beef (2- yrs)	Weaned pig (<30 kg)		Ram
Heifer, beef (1-2 yrs)	Weaned pig (<50 kg)	Growing turkey	Lamb
Heifer, dairy (2- yrs)		Turkey breeder hen	
Heifer, dairy (1-2 yrs)		Turkey breeder male	Female goat
Heifer, small (>2 yrs)		Other poultry	Male goat
Heifer, small (1-2 yrs)			Goatling
Bull, beef (>2 yrs)			Fox breeder, female

CATTLE	PIGS	POULTRY	OTHER ANIMALS
Bull, beef (1-2 yrs)			Fox breeder, male
Bull, dairy (>2 yrs)			Fox grower
Bull, dairy (1-2 yrs)			
Bull, indigenous (1-2 yrs)			Mink breeder, female
Bull, indigenous (>2 yrs)			Mink breeder, male
			Mink grower
Calf, female, beef (< 6 m)			Reindeer
Calf, female, beef (6-12 m)			
Calf, female, dairy (< 6 m)			
Calf, female, dairy (6-12 m)			
Calf, female, indigenous (< 6 m)			
Calf, female, indigenous (6-12 m)			
Calf, male, beef (< 6 m)			
Calf, male, beef (6-12 m)			
Calf, male, dairy (< 6 m)			
Calf, male, dairy (6-12 m)			
Calf, male, indigenous (< 6 m)			
Calf, male, indigenous (6-12 m)			

Table 5.10.b. Animal categories in the calculation model; the simpler categorisation. The animal categories are the same as those in the Finnish normative manure system (Luostarinen et al. 2017).

CATTLE	PIGS	POULTRY	ALS
Dairy cow	Sow (with piglets)	Laying hen breeder (female)	Horse
Suckler cow	Boar (50- kg)	Cockerel (laying hen breeder, male)	Pony
Heifer >1 yr	Fattening pig (50- kg)	Broiler	Sheep
Bull >1 yr	Weaned pig (20-50 kg)	Broiler breeder hen	Goat
Calf <1 yr		Broiler breeder, male	Fox and racoon
		Laying hen pullet	Mink and fitch
		Turkey	Reindeer
		Other poultry	

N-flow checking tool

In the Calculation Module 1, the calculation of nitrogen flow for manure is rather intricate, and it is crucial to verify that the calculated output, representing the sum of nitrogen emissions from each manure management phase and the remaining nitrogen at the end of the manure management chain, aligns with the initial nitrogen amount in the chain. In the Finnish calculation system, the verification can be performed separately for each animal category. The system compiles nitrogen data from each manure management phase, individually for each manure type, as well as for manure left in pastures and dry lots. Additionally, the system accounts for anaerobically digested manure that is returned for spreading on the field. An illustrative example of the checking tool is provided in ANNEX I of the Agriculture IIR, demonstrating a check for dairy cows.

5.4 Manure Management (NFR 3B)

Changes in chapter	
February 2026	JG, JM, TF

Source category description

This sector covers management of manure from domestic livestock.

Figure 5.9 K. Inha: Finnish agriculture, series of photographs, 1899, photographed scenes of Finnish agricultural work for the World´s Fair (Exposition Universelle) in Paris in 1900.

Finland reports emissions from manure management of cattle (including dairy cows, suckler cows, heifers, bulls and calves), swine, horses, goats, sheep, poultry, fur animals and reindeer.
Mules, asses, camels and buffalos are not farmed in Finland (Table 5.11).

In the Finnish emission inventory, animal category "horses" has always included all horses and ponies, including those on farms as well as recreational and racehorses. Therefore, the emissions from all horses have always been calculated and will continue to be calculated within the agricultural category. Consequently, in the Finnish inventory, source category 6A only covers emissions from cats and dogs.

Table 5.11 Animal categories in Finland.

NFR	Animal category
3B1a	Cattle, dairy
3B1b	Cattle, non-dairy
3B2	Sheep
3B3	Swine
3B4a	Buffalo - not farmed in Finland
3B4d	Goats
3B4e	Horses (all horses and ponies, see text)

NFR	Animal category
3B4f	Mules and asses - not farmed in Finland
3B4gi	Laying hens (incl cockerels)
3B4gii	Broilers
3B4giii	Turkeys
3B4giv	Other poultry - broiler hens, laying hen pullets and other poultry
3B4h	Other - reindeer and fur animals

Ammonia and nitrogen oxides

Emission trend

Figure 5.10 presents the ammonia and Figure 5.11 nitrogen dioxide emissions from manure management (NFR 3B).

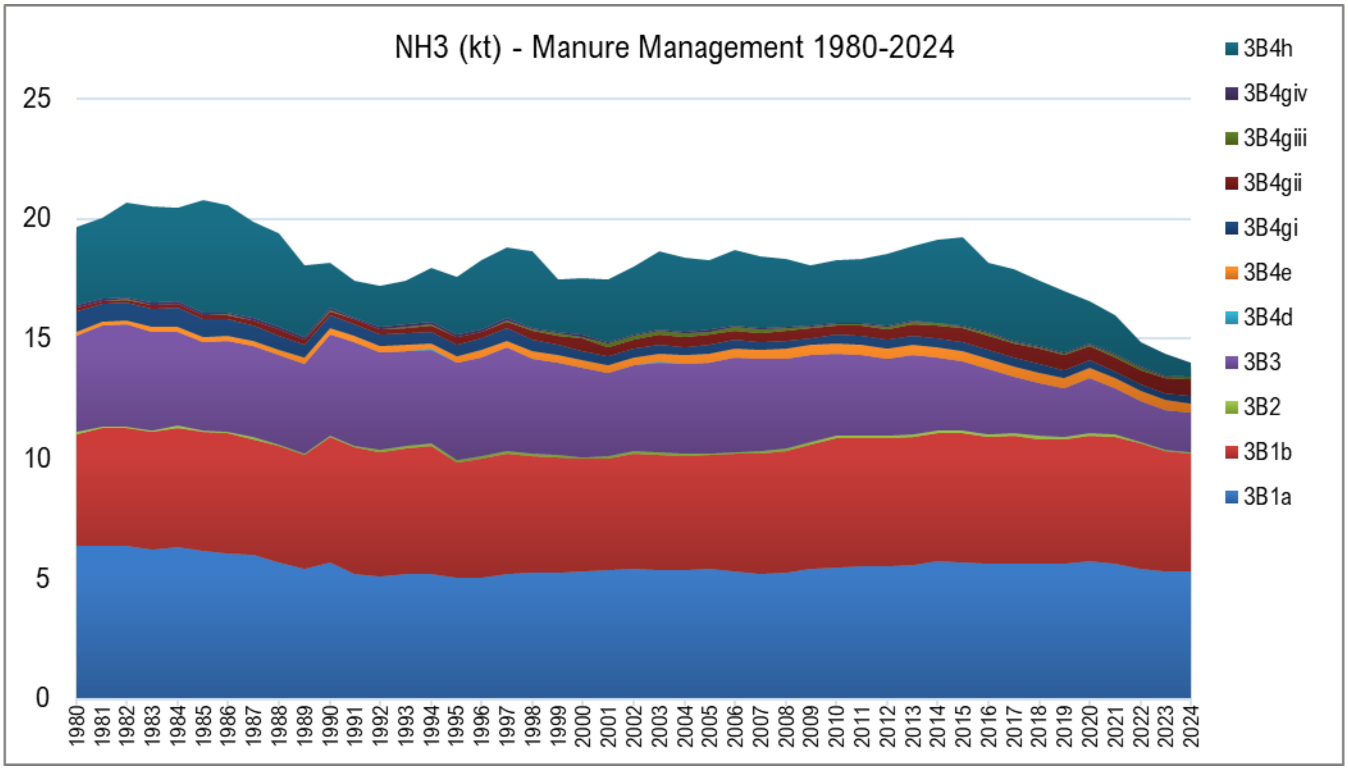


Figure 5.10 Ammonia emissions from NFR 3B categories 1980-2024

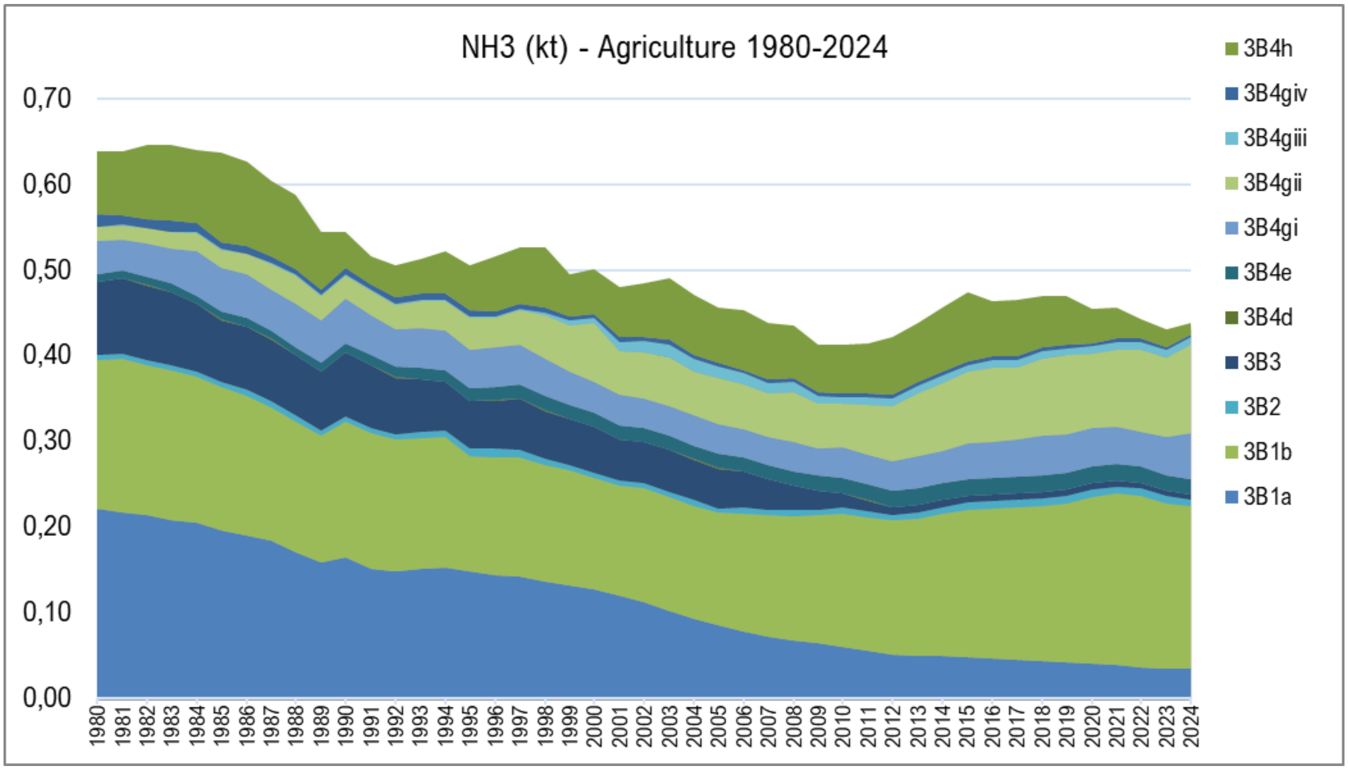


Figure 5.11 Nitrogen dioxide emissions from NFR 3B categories 1980-2024

Methodological issues

Calculation of the gaseous nitrogen emissions from manure management is based on the mass or nitrogen flow approach, as described in the model documentation (Grönroos et al. 2017), and in the UNECE and UNFCCC emission inventory guidebooks. In the method used, the pathways of nitrogen are followed starting from the nitrogen excretion of the livestock and ending at the application of manure to the fields (Figure 5.12). In each manure management phase, the gaseous losses of nitrogen are calculated. The calculation is carried out per each animal category (Table 5.10.a and 5.10.b) and for each manure management system.

In general, the Finnish agricultural ammonia emission calculation system follows the principles of the Tier 2 method described in the EMEP/EEA Guidebook 2023. However, it has some features, which move it towards the Tier 3 method, such as the greater number of animal and manure categories than listed under Tier 2, and the inclusion of the emission abatement measures.

The manure management systems considered are (manure type acronym in brackets):

- slurry (S)
- deep litter (DL)
- solid manure system (SMS), divided into two separate systems:
    - farmyard manure system (FYM; urine absorbed in bedding material)
    - solid separation system (SS; urine and faeces managed separately, produces two kinds of manure: dung with bedding (SSD), and urine (SSU)).

In contrast to the previous calculation systems, nitrogen flow approach is applied to total ammoniacal nitrogen (TAN) of manure in each stage of the manure management system instead of total nitrogen.

This means that also the emissions of gaseous nitrogen compounds (except nitrous oxide emissions) are estimated based on the TAN content of manure. Because the effects of dietary changes or nitrogen transformation during the manure management chain affect the TAN content of manure and TAN is the basis of ammonia and other forms of gaseous N emissions, more precise emission estimates are now attained.

Due to the needs of nitrous oxide emission calculation, total nitrogen content of manure is also included in the nitrogen flow approach, as well as nitrogen from bedding materials. Moreover, the revised system also considers the transformation of manure nitrogen during manure storage: immobilisation of solid manure TAN to organic form and mineralisation of slurry organic nitrogen to TAN.

The main manure management phases considered in the calculation system are:

- animal housing (NFR 3B),
- manure storing (NFR 3B),
- manure spreading (reported under NFR 3Da2a; in the GHG emission inventory included in the managed soils category),
- outdoor yards (NFR 3B).

Emissions from grazing are included in the model, and are reported under NFR 3Da3. In the GHG emission inventory, emissions from grazing are included in the category of managed soils.

The unabated ammonia emission factors for each animal category (unabated EF; % of TAN) and estimated reduction of ammonia emission losses achieved with abatement measures (% of loss without abatement) for manure management, manure application and grazing are presented in Table 5.12. Emission factors used for calculating nitrous oxide (N_2O) losses from manure management (including manure application) and grazing (Table 5.13), and emission factors used for calculating of nitric oxide (NO) and di-nitrogen (N_2) losses from manure management and manure application are presented in Table 5.14.

The unabated emission factors (as a proportion of TAN) are based on studies conducted under climatic conditions different from those in Finland, with the most significant difference being outdoor temperature. Cowell and ApSimon (1996), citing Oldenburg (1989), estimated that a 3°C rise in temperature increases ammonia volatilisation by 10%. For this reason, the principle of emission correction using temperature factors is applied in the Finnish emission inventory. More details can be found in Grönroos et al. (2017).

Until 2020, because of the structure of the Finnish calculation system, the average unabated ammonia emission factors for housing of cattle, pigs, poultry, sheep and goats, horses and ponies, and fur animals were used. For example, for slurry in pig housing, an average EF of 31 was used for all pig categories, although in the EMEP/EEA Guidebook there are separate unabated EFs for sows (35) and fattening pigs (27). During the updating process of the calculation system in 2021, it was modified so that it is possible to use more detailed animal specific emission factors for all animal groups. The new calculation system was used for the first time in 2022 reporting.

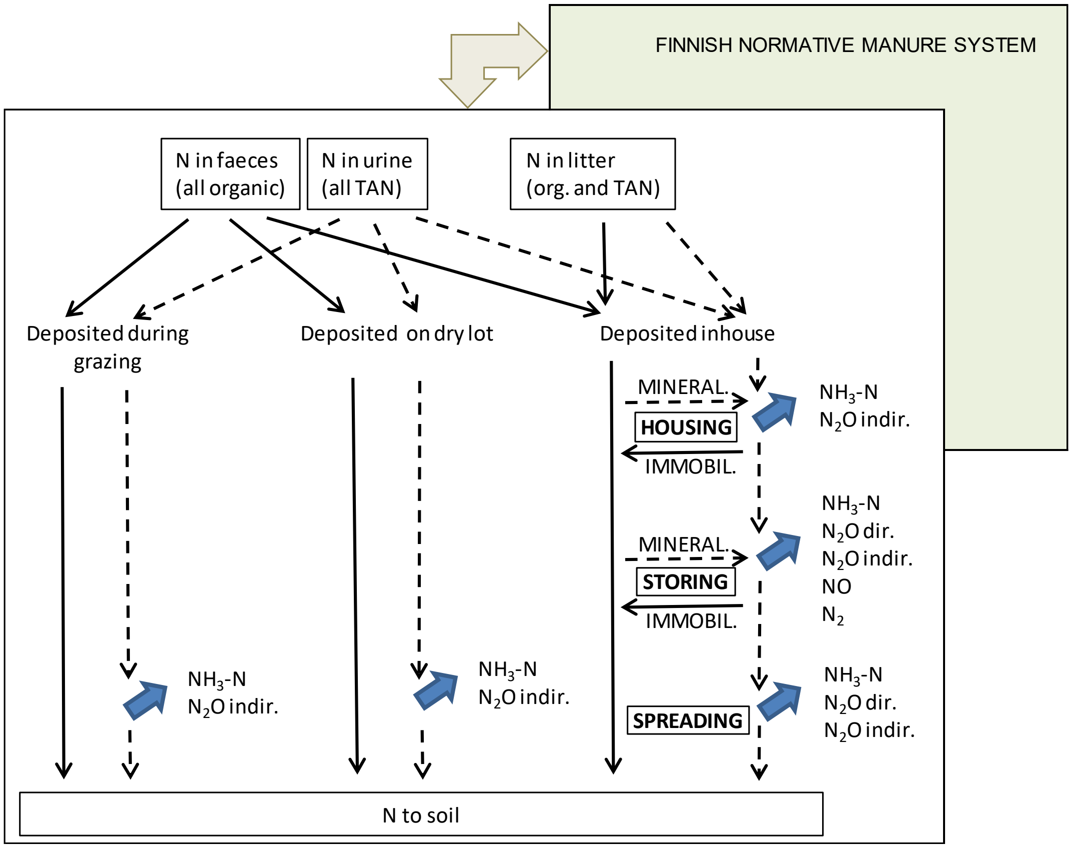


Figure 5.12. Schematic diagram of the N flows in manure management (incl. manure application, grazing and dry lots) and the related gaseous nitrogen emission calculation system used for calculating the NH_3, N_2O, NO and N_2 emissions from manure management in Finland. Nitrogen transformation processes (immobilisation and mineralisation) are shown, as well as the link between emission calculation system and the Finnish normative manure system (see text for more information). Broad blue arrows: emissions of N-compounds to the atmosphere. Emissions are calculated separately for each animal category and manure management system. For clarity, all manure management systems are not shown in the figure. Additionally, the manure N flow to the anaerobic digestion and back to the agricultural system is not shown in the diagram.

Table 5.12. Unabated emission factors (unabated EF; % of TAN) and estimated reduction of losses achieved with abatement measures (am, % of loss without abatement) for ammonia (EMEP/EEA Guidebook 2023).

	CATTLE					PIGS					POULTRY			SHEEP, GOAT		HORSE, PONY		FUR ANIMALS
	Slurry	Deep litter	FYM	Urine	Dung	Slurry	Deep litter	FYM	Urine	Dung	Slurry	Deep litter	Solid manure	Deep litter	FYM	Deep litter	FYM	FYM
Housing																		
Unabated EF	*24 or 9*[a]	*32*	*8 or 9*[a]	*8 or 9*[a]	*8 or 9*[a]	*27 or 35*[b]	*29*	*23 or 24*[c]	*23 or 24*[c]	*23 or 24*[c]	*41*	*21 or 35*[d]	*20*	*32*	*22*	*35*	*22*	*40*
am: rapid urine separation			15	20				15	20		*60*		*85*		15		15	0
am: flushing	60					60							10					
am: improved cleaning	10		10	10	10	10		10	10	10			50[e]		10		10	0
am: increased manure removal frequency	10		10	10	10	25		10	10	10	10		50		10		10	0
am: biol. or chem. air scrubbers	85	85	85	85	85	85	85	85	85	85	85	85		85	85	85	85	0
am: cooling of slurry channels	30					30												
Filling the manure storage																		
from the top	*5*					*5*					*5*							
from the bottom	*0*					*0*					*0*							
Storing																		
Unabated EF	*25*	*32*	*32*	*25*	*32*	*11*	*29*	*29*	*11*	*29*	*14*	*30*	*8*	*32*	*32*	*35*	*35*	*35*
am: tight roof (concrete)	95			95		95			95		95							
am: floating cover	60			60		60			60		60							
am: natural crust	40					40					40							
am: roof of solid manure storage		10	10		10		10	10		10		10	10	10	10	10	10	10
am: filling the solid manure storage from the bottom			30		30			30		30			30		30		30	30
am: tent, roof	80					80					80							

[a] Emission factor for loose housing (first value) and tied housing (second value). Tied housing EF is only used for dairy cows.
[b] 35 for sows, 27 for other pigs
[c] 24 for sows, 23 for other pigs
[d] 35 for turkeys and other poultry, 21 for others (layers, broilers etc)
[e] this is for a measure of "manure drying on manure belt" and is used only for poultry (laying hens)

FYM = solid manure with urine

	CATTLE					PIGS					POULTRY			SHEEP, GOAT		HORSE, PONY		FUR ANIMALS
	Slurry	Deep litter	FYM	Urine	Dung	Slurry	Deep litter	FYM	Urine	Dung	Slurry	Deep litter	Solid manure	Deep litter	FYM	Deep litter	FYM	FYM
Spreading on arable land																		
Unabated EF (broadcast spr)	*55*	*68*	*68*	*50*	*68*	*29 or 40* [f]	*45*	*45*	*25 or 35* [g]	*45*	*69*	*38* [h]	*45*	*90*	*90*	*90*	*90*	*80*
am: incorporation with ploughing < 4 hrs	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
am: incorp. with ploughing < 12 hrs	45	50	50	45	50	45	50	50	45	50	45	50	50	50	50	50	50	50
am: incorp. with ploughing > 12 hrs	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
am: incorp. with harrowing < 4 hrs	60	50	50	60	50	60	50	50	60	50	60	50	50	50	50	50	50	50
am: incorp. with harrowing < 12 hrs	35	25	25	35	25	35	25	25	35	25	35	25	25	25	25	25	25	25
am: incorp. with harrowing > 12 hrs	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
am: injection	78			78		78			78		78							
am: band spreading	30			30		30			30		30							
Spreading on plant covered land																		
Unabated EF (broadcast spr)	*55*	*68*	*68*	*50*	*68*	*29 or 40* [f]	*45*	*45*	*25 or 35* [g]	*45*	*69*	*38* [h]	*45*	*90*	*90*	*90*	*90*	*80*
am: band spreading	35			35		35			35		35							
am: injection	78			78		78			78		78							
am: band spreading + acid	75					75					75							

[f] 29 for sows' and boars' slurry, 40 for fattening and weaned pigs' slurry
[g] 25 for sows' and boars' urine, 35 for fattening and weaned pigs' urine
[h] 38 is used for broilers and for all other poultry on deep litter (e.g. turkeys)

FYM = solid manure with urine

	CATTLE					PIGS					POULTRY			SHEEP, GOAT		HORSE, PONY		FUR ANIMALS
	Slurry	Deep litter	FYM	Urine	Dung	Slurry	Deep litter	FYM	Urine	Dung	Slurry	Deep litter	Solid manure	Deep litter	FYM	Deep litter	FYM	FYM
Spreading on stubble or on grass to be terminated																		
Unabated EF (broadcast spr)	*55*	*68*	*68*	*50*	*68*	*29 or 40* [f]	*45*	*45*	*25 or 35* [g]	*45*	*69*	*38* [h]	*45*	*90*	*90*	*90*	*90*	*80*
am: incorp. with ploughing < 4 hrs	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
am: incorp. with ploughing < 12 hrs	45	50	50	45	50	45	50	50	45	50	45	50	50	50	50	50	50	50
am: incorp. with ploughing > 12 hrs	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
am: incorp. with harrowing < 4 hrs	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
am: incorp. with harrowing < 12 hrs	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
am: incorp. with harrowing > 12 hrs	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
am: injection	78			78		78			78		78							
am: band spreading	30			30		30			30		30							
Grazing																		
evaporate from urine	*14*					*10*					*10*			*9*		*35*		
evaporate from faeces	*14*					*10*					*10*			*9*		*35*		
Yards																		
evaporate from urine	*40*					*53*					*40*			*75*		*35*		
evaporate from faeces	*40*					*53*					*40*			*75*		*35*		

[f] 29 for sows and boars slurry, 40 for fattening and weaned pigs slurry
[g] 25 for sows' and boars' urine, 35 for fattening and weaned pigs' urine
[h] 38 is used for broilers and also for all other poultry on deep litter (e.g. turkeys)

FYM = solid manure with urine

Table 5.13. Emission factors used for calculating nitrous oxide (N_2O) losses from manure management (including manure application) and grazing (IPCC 2019).

Emission source category	EF (% of tot-N excreted)
Manure management:	
- daily spread	0.0%
- solid storage	1.0%
- yards	2.0%
- liquid/slurry - WITH natural crust cover	0.5%
- liquid/slurry - WITHOUT natural crust cover	0.0%
- uncovered anaerobic lagoon	0.0%
- pit storage below animal confinements	0.2%
- anaerobic digester	0.0%
- burned for fuel or as waste	0.0%
- burned for fuel or as waste	0.0%
- cattle and swine deep bedding - NO MIXING	1.0%
- cattle and swine deep bedding - ACTIVE MIXING	7.0%
- composting - In-Vessel	0.6%
- composting - Static Pile	1.0%
- composting - Intensive Windrow	0.5%
- composting - Passive Windrow	0.5%
- poultry manure with litter	0.1%
- poultry manure without litter	0.1%
- aerobic treatment - NATURAL	1.0%
- aerobic treatment - FORCED	0.5%
Managed soils (N additions)	0.6%
Grazing of cattle, poultry and pigs	0.6%
Grazing of sheep and other livestock	0.3%
INDIRECT N_2O-N (due to volatilisation of NH_3 and NO)	1.4%

Table 5.14. Emission factors used for calculating of nitric oxide (NO) and di-nitrogen (N_2) losses from manure management and manure application (EMEP/EEA Guidebook 2023).

Parameter	Emission source	Emission factor
NO-N	Inhouse, slurry	NA
	Inhouse, solid manure	NA
	Storage, slurry	0.01% of TAN
	Storage, solid manure	1.0% of TAN
	Application, solid and liquid manure, and mineral N	1.22% of tot-N applied
N_2	Inhouse, slurry	NA
	Inhouse, solid manure	NA
	Storage, slurry	0.3% of TAN
	Storage, solid manure	30.0% of TAN

Until 2021, anaerobic digestion was not considered in the agricultural emission calculation system. This was because the amount of anaerobically treated manure was considered so small (ca 1% of all manure) that it was not seen essential to make major changes to the calculation system. However, the calculation system was supplemented in this respect during 2021, and the new system was used for the first time in 2022 reporting.

A detailed description of the calculation of emissions is provided in the document Grönroos et al., 2017, Chapter 2.1.1.2 (available in the 2018 EIONET CDR submission folder).

Activity data

Animal numbers are received from Statistical services of the Natural resources institute Finland (Luke), the Finnish Trotting and Breeding Association of horses (Suomen Hippos) and from the statistics of the Finnish Fur Breeders' Association, as presented in Tables 5.15a-c. As was mentioned earlier, number of horses include all horses and ponies, including those on farms as well as recreational and racehorses. This means that no horses are considered in the source category 6A (other).

The number of reindeer is taken from the Yearbook of Farm Statistics or the E-Yearbook of Food and Natural Resource Statistics (https://stat.luke.fi/en/e-yearbook-food-and-natural-resource-statistics-2017-2017_en), or, for the years 2018 - 2024, obtained directly from Luke Statistical Services. The number of reindeer corresponds to the number of reindeers left alive during the reindeer herding year.

Animal-specific nitrogen excretion rates are based on the nutrient balance calculations carried out by Natural Resources Institute Finland (Luke; Table 5.16a-b). Besides this, also other excretion data used in the agricultural emission calculation are based on the data provided by Luke and are the same as are used in the national GHG emission inventory. For the 2025 reporting, the entire nitrogen excretion time series (1980–2023) for pigs, horses, and ponies was updated using new excretion values calculated by the Natural Resources Institute Finland (Luke).

For fur farming, emissions are calculated using the number of cubs produced during a year, along with excretion values per cub per year as activity data. Since the 2023 reporting, the whole time series of fur animal numbers was updated to be based on the numbers of produced cubs instead of the statistics on annually sold pelts because they have showed unexceptionally low volumes for 2019 and beyond. The problem with using the number of sold pelts as activity data was that the quantity of pelts sold no longer corresponded to the level of production. A significant portion of the pelts appeared to be stored, presumably in anticipation of better selling prices.

For the years 1980-1989 there were no statistics of the numbers of produced cubs. For those years, cub/pelt ratio of the beginning of 1990s (1.1 for foxes and 1.04 for minks) was used to convert numbers of pelts to numbers of cubs.

Separate emission calculations are made for foxes and raccoons, and minks and fitches. The nitrogen and volatile solids (VS) excretion rates of cubs (provided by the Natural Resources Institute Finland, Luke) are calculated to also include the excretion of breeding animals, eliminating the need for separate calculations of emissions from breeding animals. This is also why the numbers of breeding animals are not needed in the emission calculation. The same methodology and activity data is used in the national greenhouse gas emission inventory (responsible organisation is Luke), where a similar transition from using the number of cubs instead of the number of sold pelts has also been implemented.

Table 5.15a Animal numbers in Finland for cattle and swine 1980, 1985-2024 (x 1 000 heads).

Year	Dairy cow	Suckler cow	Bull >1 yr	Calf <1 yr	Heifer >1 yr	Boar (50- kg)	Fattening pig (50- kg)	Sow (with piglets)	Weaned pig (20-50 kg)
1980	720	8	109	676	233	6	447	182	320
1985	628	9	125	631	215	5	404	165	289
1986	607	9	131	602	218	6	413	169	296
1987	589	9	125	558	217	6	420	172	301
1988	551	10	130	538	215	6	409	167	293
1989	507	9	134	490	206	5	405	165	290
1990	490	14	149	488	219	6	476	179	283
1991	446	21	144	486	214	6	464	174	276
1992	428	28	143	463	211	6	448	168	266
1993	426	33	139	437	217	5	439	165	261
1994	417	33	144	425	215	6	448	168	266
1995	399	29	109	422	189	7	491	161	277
1996	392	31	115	407	201	7	484	180	279
1997	391	32	121	402	197	7	512	185	332
1998	383	31	115	398	190	8	458	187	323
1999	372	30	118	379	188	6	469	180	269
2000	364	28	115	365	185	6	441	184	262
2001	355	27	111	362	182	5	426	164	264
2002	348	28	115	354	180	5	441	172	268
2003	334	28	115	344	179	5	483	178	269
2004	324	31	110	330	173	5	480	175	264
2005	319	35	108	329	169	4	500	177	280
2006	309	39	112	318	171	4	498	171	296
2007	296	43	110	311	166	4	525	177	329
2008	289	48	109	305	165	4	533	167	312
2009	290	52	110	304	163	4	535	156	303
2010	289	55	114	303	164	3	526	146	304
2011	286	57	111	299	162	3	531	134	288
2012	284	58	109	303	160	2	534	130	277
2013	283	57	110	300	162	2	534	122	273
2014	285	58	110	303	158	2	507	118	269
2015	285	59	109	307	155	2	501	116	275
2016	282	59	108	310	150	2	489	108	256
2017	275	60	111	297	150	1	447	99	249
2018	271	60	106	299	146	1	425	95	246
2019	262	60	105	288	142	1	439	92	258
2020	260	62	98	290	136	1	451	89	264
2021	254	64	102	289	137	1	405	93	256
2022	248	65	102	281	137	0.8	380	85	231
2023	242	65	100	281	133	0.8	367	84	229
2024	234	63	97	271	129	0.8	365	83	227

Table 5.15b Animal numbers in Finland for poultry, sheep and goat 1980, 1985-2024 (x 1 000 heads).

Year	Broiler breeder hen	Broiler	Laying hen pullet	Cockerel (laying hen breeder, male)	Laying hen breeder (female)	Other poultry	Turkey	Goat	Sheep
1980		1867	2435	50	6041	20	60	6	106
1985		2654	1547	50	5922	20	60	6	112
1986		2884	1505	50	5532	20	60	6	116
1987		3319	1449	50	5342	20	60	6	126
1988		3754	1441	50	5238	20	60	6	119
1989		3374	1415	50	4923	20	60	6	108
1990	62	2993	1633	50	4845	21	60	6	103
1991	97	3250	1304	45	4138	32	64	5	107
1992	133	3506	1598	40	3969	43	68	5	108
1993	168	3763	1522	35	4025	54	72	5	120
1994	203	4020	1422	30	4090	65	76	6	121
1995	240	4276	1482	25	4179	75	80	6	159
1996	279	4052	1246	25	4184	54	96	7	150
1997	299	4911	1288	32	4152	33	112	8	150
1998	347	5507	1185	30	3802	35	145	8	128
1999	382	5998	1025	17	3361	39	210	8	107
2000	364	7918	914	18	3110	32	215	9	100
2001	394	5412	1043	12	3202	35	455	7	96
2002	402	5766	772	9	3213	41	531	7	96
2003	346	6050	931	10	3016	40	603	7	98
2004	287	5573	912	10	3069	18	535	7	109
2005	457	5472	954	12	3128	20	495	7	90
2006	405	5366	844	13	3103	15	493	7	117
2007	351	5074	764	13	3134	24	431	6	119
2008	339	5675	865	19	3190	19	415	6	122
2009	329	4918	859	15	2926	16	306	6	118
2010	433	4616	838	14	3394	12	280	5	126
2011	421	5421	745	22	3304	14	308	5	129
2012	471	6038	743	27	3173	14	295	5	130
2013	520	6861	858	22	3432	13	274	5	136
2014	544	7341	714	25	3645	15	292	4	138
2015	548	7827	662	26	3595	23	246	5	155
2016	523	8272	748	26	3599	17	260	5	157
2017	473	8047	509	22	3746	47	292	5	156
2018	424	8781	608	17	3985	26	299	5	155
2019	395	9112	647	16	3900	27	263	6	145
2020	396	8507	566	18	3812	10	268	6	140
2021	479	8499	796	22	3729	11	287	6	131
2022	598	8901	645	24	3866	9	294	6	132
2023	607	8717	569	30	4056	15	284	6	122
2024	592	9792	496	36	4041	9	314	5	115

Table 5.15c Animal numbers in Finland for fur animals, reindeer, horses and ponies 1980, 1985-2024 (x 1 000 heads).

Year	Fox and racoon	Mink and fitch	Reindeer	Horse	Pony
1980	1926	4375	186	30	1
1985	3429	5238	221	34	3
1986	3718	4141	230	35	4
1987	3492	3503	229	31	4
1988	3208	3660	227	34	5
1989	2195	3288	256	36	5
1990	1508	1838	239	39	6
1991	1125	1604	260	42	6
1992	1366	1683	232	43	6
1993	1525	1584	215	43	6
1994	1939	1870	214	42	6
1995	2042	1939	208	44	6
1996	2622	2041	213	46	6
1997	2588	2117	203	48	7
1998	2866	2112	196	49	7
1999	1762	1803	195	50	7
2000	1905	1901	203	51	7
2001	2104	2001	186	52	7
2002	2268	2001	200	52	7
2003	2670	2001	197	53	7
2004	2601	1701	201	54	7
2005	2207	1901	207	56	8
2006	2346	2001	198	58	8
2007	2073	2100	193	60	9
2008	1947	1801	195	61	9
2009	1636	1900	193	63	9
2010	1697	1900	194	65	10
2011	1883	1700	196	65	10
2012	2164	1800	192	65	10
2013	2186	2000	192	65	10
2014	2437	2100	187	64	10
2015	2796	1900	191	64	10
2016	2168	1620	191	64	10
2017	2282	1448	193	64	10
2018	2092	1368	185	64	10
2019	2060	1042	188	64	10
2020	1413	768	195	64	10
2021	1266	778	183	64	10
2022	773	538	185	59	13
2023	689	516	180	60	12
2024	386	413	184	58	12

Manure management data

Before 2013, data on manure management and emission abatement techniques based mainly on expert opinions and on some statistical data. In 2013, a questionnaire on manure management was sent to ca 10 000 livestock farms to collect more recent and detailed data. The results from the survey were used in updating the emission calculation system.

Changes in legislation and Agri-environmental support system in 2014-2015 caused changes in manure management practices and have been considered in emission calculation too. Some new statistical data and data from Ministry of Agriculture and Forestry about the implementation of the new agri-environmental measures related to slurry injection have been considered as well. New data on manure management practices was collected in a survey in early 2021 (Agricultural Census 2020) but all results related to manure management practices were not available before 2025 reporting.

A survey on manure management practices was sent to farmers in 2022, and the results were available for the 2025 reporting. However, due to a low response rate, the survey did not provide sufficient information on certain aspects and animal categories. Therefore, data from the Agricultural Census 2020 were used when deemed a better alternative.

A comprehensive manure management data set, including the penetration rates of abatement measures, covering the whole time series 1980-2024 is provided in Annex II of the Agriculture IIR.

Implied ammonia emission factors

The domestic (implied) emission factors (IEFs; kg NH_3/animal place/year) calculated on basis of national studies (Grönroos et al 2017) are presented in Table 5.17. The emission factors include emissions from animal shelter, manure storing and application, grazing and dry lot.

Due to the cold climate, grazing period is relatively short in Finland. For example, for sheep the grazing period is averagely 153 days whereas e.g. in the EMEP/EEA Guidebook 2016, the housing period for sheep is 30 days thus implicating a grazing period of 335 days. In Finland, the short grazing period might lead to the higher manure management IEFs of some animal categories.

Table 5.16a. Time series for animal-specific nitrogen excretion rates (kg N/animal place/year) used in the 2026 submission: cattle, pigs, horses, ponies, goats, and sheep.

Year	Dairy cow	Calve <1 yr	Bull >1 yr	Heifer >1 yr	Suckler cow	Weaned pig	Fattening pig	Sow	Boar	Horse	Pony	Goat	Sheep
1980	86.05	26.68	48.55	45.01	56.30	5,75	21,51	28,59	19,92	46,40	25,02	10.70	7.28
1985	91.14	27.91	51.60	45.58	56.30	5,52	20,78	28,57	19,48	45,22	24,74	10.70	7.28
1986	92.10	28.19	51.89	45.67	56.52	5,49	20,68	28,70	19,46	45,20	24,59	10.70	7.28
1987	92.88	28.70	52.08	45.92	56.76	5,31	20,13	28,97	19,96	44,70	24,91	10.70	7.28
1988	93.69	28.55	52.09	46.05	57.00	5,29	20,15	28,99	20,06	44,72	24,85	10.70	7.28
1989	95.95	29.30	53.97	47.18	57.24	5,27	20,10	28,83	19,89	44,74	24,92	10.70	7.28
1990	97.77	30.00	55.91	48.55	57.59	5,25	20,10	28,60	20,15	44,58	24,86	10.70	7.50
1991	97.82	30.05	56.77	48.44	57.58	5,28	20,12	32,01	20,17	44,61	25,04	10.70	7.50
1992	97.88	29.80	56.42	48.02	57.27	5,26	20,01	30,79	19,59	44,60	25,09	10.70	7.50
1993	99.29	30.23	56.45	49.35	58.19	5,23	19,91	29,98	19,27	44,60	25,02	10.70	7.50
1994	101.33	30.51	57.18	49.89	58.72	5,07	19,59	29,17	18,96	44,62	24,82	10.70	7.50
1995	101.86	30.47	56.91	50.01	58.68	4,95	19,33	28,91	19,04	44,62	24,64	10.70	7.50
1996	102.66	30.86	57.51	51.08	59.46	4,83	19,08	28,39	18,93	44,64	24,61	10.70	7.68
1997	104.93	31.07	57.27	51.58	59.92	4,76	18,91	28,17	18,99	44,64	24,63	10.70	7.56
1998	105.57	31.11	57.12	52.26	59.78	4,59	18,65	27,80	19,03	44,62	24,78	10.70	7.37
1999	107.72	31.28	57.53	52.51	60.00	4,53	18,50	27,44	19,05	44,76	24,78	10.70	7.65
2000	110.61	31.34	58.25	52.48	59.15	4,46	18,33	27,86	19,70	44,59	25,34	10.70	7.61
2001	112.52	31.84	59.59	53.09	59.71	4,31	18,12	27,60	19,82	44,58	25,10	10.70	7.13
2002	114.96	32.72	61.95	54.09	60.90	4,23	17,94	27,54	20,09	44,55	25,10	10.70	7.60
2003	116.53	33.31	63.73	54.51	61.42	4,22	17,85	26,79	19,86	44,52	24,99	10.70	7.65
2004	118.60	33.87	65.21	54.99	62.43	4,15	17,68	26,97	20,24	44,45	24,81	10.70	7.58
2005	119.47	33.82	65.16	55.35	62.09	4,01	17,48	26,81	20,47	44,38	25,13	10.70	7.42
2006	120.11	33.93	66.10	54.85	62.50	4,20	18,35	27,99	21,69	44,39	24,92	10.70	7.48
2007	122.17	34.59	67.50	55.67	63.47	3,79	17,01	26,01	20,56	44,33	24,90	10.70	7.37
2008	123.27	34.69	67.41	56.13	63.90	3,63	17,26	24,94	20,08	44,37	24,83	10.70	7.48
2009	124.73	34.64	67.35	56.09	64.26	3,59	17,16	24,52	19,91	44,25	24,65	10.70	7.49
2010	125.70	35.09	68.48	56.62	65.00	3,43	16,88	24,13	20,16	44,23	24,96	10.70	7.36
2011	125.96	34.99	67.67	57.02	65.76	3,42	17,12	23,31	19,94	44,19	24,62	10.70	7.49
2012	125.51	34.72	66.54	57.16	65.46	3,26	16,61	22,42	19,58	44,18	24,62	10.70	7.34
2013	127.61	34.65	65.83	57.53	65.94	3,35	17,85	23,38	21,07	44,19	24,49	10.70	7.41
2014	130.47	35.07	66.62	57.49	66.32	3,34	17,35	23,99	21,43	44,19	24,40	10.70	7.41
2015	131.05	35.66	67.87	57.95	66.58	3,12	17,10	23,07	21,28	44,20	24,27	10.70	7.48
2016	131.28	35.69	67.91	58.06	67.13	3,35	17,33	22,43	21,31	44,17	24,27	10.70	7.52
2017	134.89	36.06	68.55	58.34	66.89	3,39	16,64	22,21	21,42	44,16	24,20	10.70	7.65
2018	136.37	36.33	69.43	58.33	66.85	3,36	16,38	23,17	21,82	44,13	24,14	10.70	7.82
2019	140.10	37.31	70.67	59.91	67.78	3,00	15,41	20,62	21,27	44,18	24,18	10.70	7.95
2020	144.61	38.41	72.07	61.69	69.71	3,33	17,47	22,95	20,81	44,15	24,10	10.70	7.95
2021	144.96	38.80	71.36	62.76	69.84	3,37	15,51	23,02	20,98	44,15	24,12	10.70	7.84
2022	143.36	38.24	70.35	62.29	69.83	3,34	15,21	22,44	20,96	44,00	24,31	10.70	7.93
2023	143.88	37.15	70.04	60.04	68.11	3,34	15,21	22,44	20,97	43,97	24,31	10.70	7.90
2024	149.04	37.68	69.79	61.05	68.51	3.34	15.21	22.44	20.97	43.97	24.31	10.70	7.89

Table 5.16b. Time series for animal-specific nitrogen excretion rates (kg N/animal place/year) used in the 2026 submission: poultry, fur animals and reindeer.

Year	Broiler hen	Broiler	Laying hen	Laying hen pullet	Cockerel	Turkey	Other poultry	Fox and racoon	Mink and fitch	Reindeer
1980	0.992	0.441	0.631	0.353	0.969	1.074	0.620	2.13	1.24	10.70
1985	0.992	0.428	0.572	0.353	0.969	1.074	0.620	2.13	1.24	10.70
1986	0.992	0.426	0.585	0.353	0.969	1.076	0.620	2.13	1.24	10.70
1987	0.992	0.457	0.555	0.353	0.969	1.078	0.620	2.13	1.24	10.70
1988	0.992	0.454	0.556	0.353	0.969	1.078	0.620	2.13	1.24	10.70
1989	0.992	0.452	0.546	0.353	0.969	1.080	0.620	2.13	1.24	10.70
1990	0.992	0.449	0.567	0.353	0.969	1.080	0.623	2.13	1.24	10.70
1991	0.992	0.425	0.585	0.356	0.969	1.195	0.641	2.15	1.25	10.70
1992	0.992	0.376	0.578	0.359	0.969	1.206	0.635	2.17	1.26	10.70
1993	0.992	0.401	0.605	0.362	0.969	1.315	0.663	2.19	1.26	10.70
1994	0.992	0.399	0.599	0.366	0.969	1.240	0.658	2.21	1.27	10.70
1995	0.992	0.396	0.588	0.369	0.969	1.300	0.648	2.24	1.27	10.70
1996	0.992	0.366	0.607	0.372	0.969	1.285	0.667	2.26	1.28	10.70
1997	0.992	0.363	0.605	0.376	0.969	1.307	0.665	2.28	1.29	10.70
1998	0.992	0.416	0.615	0.379	0.969	1.336	0.675	2.30	1.29	10.70
1999	0.992	0.414	0.612	0.382	0.969	1.363	0.673	2.32	1.30	10.70
2000	0.992	0.411	0.616	0.385	0.969	1.423	0.677	2.34	1.31	10.70
2001	0.992	0.409	0.601	0.389	0.969	1.422	0.661	2.42	1.31	10.70
2002	0.992	0.406	0.585	0.389	0.969	1.479	0.644	2.51	1.31	10.70
2003	0.992	0.430	0.607	0.389	0.969	1.483	0.669	2.59	1.31	10.70
2004	0.992	0.428	0.615	0.389	0.969	1.532	0.678	2.67	1.31	10.70
2005	0.992	0.425	0.598	0.389	0.969	1.536	0.661	2.75	1.31	10.70
2006	0.992	0.422	0.583	0.389	0.969	1.482	0.646	2.84	1.31	10.70
2007	0.992	0.446	0.575	0.388	0.969	1.497	0.637	2.92	1.31	10.70
2008	0.992	0.479	0.573	0.388	0.969	1.499	0.636	3.00	1.31	10.70
2009	0.992	0.483	0.576	0.388	0.969	1.595	0.636	3.00	1.31	10.70
2010	0.992	0.476	0.574	0.388	0.969	1.606	0.636	3.00	1.31	10.70
2011	0.992	0.477	0.579	0.388	0.969	1.583	0.636	3.00	1.31	10.70
2012	0.992	0.477	0.598	0.388	0.969	1.606	0.636	3.00	1.31	10.70
2013	0.992	0.477	0.595	0.388	0.969	1.652	0.636	3.00	1.31	10.70
2014	0.992	0.477	0.574	0.388	0.969	1.595	0.636	3.00	1.31	10.70
2015	0.992	0.478	0.623	0.388	0.969	1.629	0.636	3.00	1.31	10.70
2016	0.992	0.479	0.615	0.388	0.969	1.629	0.636	3.00	1.31	10.70
2017	0.992	0.478	0.601	0.389	0.969	1.663	0.636	3.00	1.31	10.70
2018	0.992	0.478	0.601	0.389	0.969	1.640	0.636	3.00	1.31	10.70
2019	0.992	0.478	0.583	0.388	0.969	1.695	0.636	3.00	1.31	10.70
2020	0.992	0.479	0.593	0.388	0.969	1.695	0.636	3.00	1.31	10.70
2021	0.992	0.479	0.574	0.388	0.969	1.695	0.636	3.00	1.31	10.70
2022	0.992	0.478	0.522	0.388	0.969	1.695	0.636	3.00	1.31	10.70
2023	0.992	0.479	0.522	0.388	0.969	1.695	0.636	3.00	1.31	10.70
2024	0.992	0.480	0.643	0.388	0.969	1.695	0.636	3.00	1.31	10.70

Table 5.17a Implied NH_3 emissions factors for cattle and swine, including housing, manure storing, pasturing, dry lots and manure application (kg NH_3 / animal place).

Year	Dairy cow	Suckler cow	Heifer >1 yr	Bull >1 yr	Calf <1 yr	Sow (with piglets)	Boar (50-kg)	Fattening pig (50-	Weaned pig (20-50
1980	19.018	13.485	10.593	15.047	6.979	8.293	6.945	7.551	2.130
1981	19.324	13.507	10.645	15.270	7.122	8.425	6.911	7.525	2.114
1982	19.632	13.530	10.698	15.494	7.266	8.556	6.876	7.498	2.097
1983	19.859	13.530	10.706	15.684	7.362	8.627	6.843	7.447	2.080
1984	20.257	13.575	10.804	15.948	7.561	8.818	6.804	7.444	2.063
1985	20.574	13.598	10.858	16.178	7.713	8.949	6.766	7.416	2.047
1986	20.880	13.673	10.906	16.308	7.875	9.123	6.751	7.405	2.033
1987	21.148	13.755	10.992	16.409	8.104	9.344	6.913	7.230	1.968
1988	21.427	13.838	11.052	16.454	8.151	9.485	6.940	7.263	1.959
1989	22.042	13.921	11.352	17.091	8.458	9.564	6.871	7.269	1.951
1990	23.528	14.040	11.715	17.764	8.753	9.604	6.948	7.294	1.943
1991	23.554	14.022	11.745	18.132	8.841	10.956	6.965	7.367	1.988
1992	23.751	13.941	11.695	18.103	8.837	10.548	6.771	7.386	2.004
1993	24.167	14.120	12.081	18.177	9.031	10.280	6.670	7.406	2.018
1994	24.678	14.216	12.284	18.509	9.211	10.016	6.572	7.318	1.962
1995	24.816	14.192	12.381	18.519	9.269	9.951	6.607	7.255	1.920
1996	25.316	14.532	12.658	18.719	9.398	9.750	6.562	7.138	1.865
1997	26.147	14.811	12.788	18.647	9.469	9.667	6.579	7.060	1.833
1998	26.688	14.962	13.008	18.602	9.482	9.522	6.590	6.941	1.750
1999	27.566	15.193	13.073	18.743	9.543	9.378	6.591	6.875	1.725
2000	28.381	15.192	13.074	19.006	9.568	9.519	6.812	6.796	1.692
2001	29.431	15.389	13.243	19.481	9.746	9.438	6.863	6.726	1.627
2002	30.548	15.726	13.523	20.301	10.055	9.433	6.968	6.671	1.599
2003	31.496	15.921	13.646	20.936	10.269	9.169	6.900	6.664	1.601
2004	32.630	16.227	13.783	21.473	10.476	9.266	7.045	6.618	1.579
2005	33.564	16.233	13.922	21.486	10.477	9.222	7.139	6.558	1.519
2006	33.613	16.061	13.968	21.774	10.373	9.693	7.610	6.815	1.560
2007	34.048	16.034	14.384	22.226	10.464	9.115	7.250	6.261	1.390
2008	34.565	15.908	14.712	22.163	10.369	8.780	7.103	6.344	1.301
2009	35.063	15.796	14.916	22.132	10.233	8.699	7.054	6.253	1.268
2010	35.208	15.802	15.290	22.529	10.283	8.544	7.132	6.053	1.179
2011	35.361	15.790	15.621	22.256	10.141	8.250	7.040	6.107	1.164
2012	35.031	15.578	15.888	21.887	9.957	7.934	6.904	5.827	1.080
2013	35.451	15.452	15.879	21.507	9.802	8.134	7.321	6.161	1.093
2014	36.042	15.306	15.672	21.624	9.807	8.234	7.324	5.829	1.068
2015	35.702	15.140	15.689	21.908	9.862	7.713	7.144	5.589	0.959
2016	35.272	15.031	15.601	21.758	9.743	7.299	7.019	5.524	1.020
2017	36.199	14.771	15.558	21.813	9.727	7.069	6.911	5.146	1.013
2018	36.217	14.558	15.424	21.929	9.679	7.310	6.887	4.922	0.978
2019	36.992	15.062	15.723	22.146	9.846	6.184	6.558	4.433	0.827
2020	37.840	15.296	16.067	22.403	10.046	6.858	6.258	5.042	0.917
2021	37.534	15.121	16.202	21.927	10.028	6.706	6.142	4.251	0.908
2022	36.472	14.925	15.924	21.343	9.730	6.321	5.967	4.030	0.877
2023	36.618	14.519	15.311	21.260	9.432	6.321	5.968	4.030	0.877
2024	37.930	14.603	15.568	21.185	9.566	6.321	5.968	4.030	0.877

Table 5.17b Implied NH_3 emissions factors for Poultry, including housing, manure storing, pasturing, dry lots and manure application (kg NH_3 / animal place).

Year	Laying hen breeder (female)	Cockerel (laying hen breeder, male)	Broilers	Broiler hens	Laying hen pullet	Turkey	Other poultry
1980	0.199	0.227	0.072	0.000	0.065	0.226	0.141
1981	0.199	0.227	0.071	0.000	0.067	0.226	0.141
1982	0.198	0.227	0.071	0.000	0.069	0.226	0.141
1983	0.200	0.227	0.071	0.000	0.069	0.226	0.141
1984	0.196	0.227	0.070	0.000	0.072	0.226	0.141
1985	0.176	0.227	0.070	0.000	0.074	0.226	0.141
1986	0.178	0.227	0.069	0.000	0.076	0.226	0.141
1987	0.167	0.227	0.074	0.000	0.077	0.227	0.141
1988	0.165	0.227	0.074	0.000	0.079	0.227	0.141
1989	0.160	0.227	0.074	0.000	0.081	0.227	0.141
1990	0.164	0.227	0.073	0.161	0.083	0.227	0.141
1991	0.169	0.228	0.069	0.162	0.084	0.252	0.146
1992	0.168	0.228	0.062	0.163	0.085	0.255	0.144
1993	0.176	0.229	0.066	0.164	0.086	0.279	0.150
1994	0.175	0.229	0.066	0.165	0.087	0.264	0.149
1995	0.172	0.230	0.066	0.165	0.089	0.278	0.147
1996	0.178	0.230	0.061	0.165	0.090	0.275	0.151
1997	0.177	0.230	0.061	0.165	0.090	0.279	0.151
1998	0.180	0.230	0.069	0.165	0.091	0.285	0.153
1999	0.180	0.230	0.069	0.165	0.092	0.291	0.153
2000	0.181	0.230	0.069	0.165	0.093	0.304	0.154
2001	0.176	0.229	0.068	0.164	0.093	0.303	0.150
2002	0.171	0.229	0.067	0.163	0.092	0.313	0.146
2003	0.178	0.228	0.070	0.162	0.092	0.313	0.151
2004	0.180	0.227	0.070	0.161	0.091	0.322	0.153
2005	0.175	0.226	0.069	0.160	0.091	0.322	0.150
2006	0.169	0.219	0.068	0.160	0.088	0.309	0.145
2007	0.165	0.212	0.071	0.159	0.086	0.310	0.142
2008	0.163	0.206	0.076	0.158	0.084	0.309	0.140
2009	0.162	0.200	0.077	0.158	0.082	0.326	0.139
2010	0.160	0.195	0.076	0.157	0.080	0.327	0.138
2011	0.160	0.189	0.075	0.157	0.078	0.321	0.137
2012	0.164	0.183	0.075	0.156	0.076	0.324	0.135
2013	0.160	0.180	0.075	0.155	0.074	0.331	0.133
2014	0.151	0.177	0.074	0.155	0.073	0.318	0.131
2015	0.160	0.174	0.074	0.154	0.072	0.323	0.128
2016	0.155	0.171	0.074	0.153	0.070	0.321	0.126
2017	0.148	0.168	0.073	0.152	0.069	0.326	0.124
2018	0.144	0.165	0.073	0.152	0.067	0.320	0.121
2019	0.136	0.162	0.073	0.151	0.066	0.329	0.119
2020	0.135	0.159	0.073	0.150	0.065	0.327	0.116
2021	0.127	0.156	0.072	0.150	0.063	0.325	0.114
2022	0.112	0.153	0.072	0.149	0.062	0.324	0.112
2023	0.112	0.153	0.072	0.149	0.062	0.324	0.112
2024	0.138	0.153	0.072	0.149	0.062	0.324	0.112

Table 5.17c Implied NH_3 emissions factors for other animals, including housing, manure storing, pasturing, dry lots and manure application (kg NH_3 / animal place).

Year	Horse	Pony	Sheep	Goat	Fox and racoon	Mink and fitch	Reindeer
1980	10.843	5.955	1.308	1.922	0.834	0.487	0.873
1981	10.833	5.967	1.296	1.905	0.834	0.487	0.873
1982	10.824	5.979	1.284	1.887	0.834	0.487	0.873
1983	10.768	5.965	1.278	1.879	0.834	0.487	0.873
1984	10.803	6.002	1.262	1.855	0.834	0.487	0.873
1985	10.791	6.013	1.251	1.839	0.834	0.487	0.873
1986	10.831	6.002	1.241	1.823	0.834	0.487	0.873
1987	10.756	6.105	1.231	1.809	0.834	0.487	0.873
1988	10.805	6.114	1.221	1.794	0.834	0.487	0.873
1989	10.853	6.157	1.211	1.780	0.834	0.487	0.873
1990	10.858	6.177	1.238	1.767	0.834	0.487	0.873
1991	10.933	6.260	1.253	1.788	0.843	0.490	0.873
1992	10.971	6.296	1.268	1.809	0.851	0.492	0.873
1993	10.984	6.286	1.282	1.830	0.859	0.494	0.873
1994	10.974	6.225	1.297	1.851	0.867	0.497	0.873
1995	10.934	6.158	1.312	1.871	0.875	0.499	0.873
1996	10.939	6.150	1.344	1.871	0.884	0.501	0.873
1997	10.938	6.155	1.321	1.871	0.892	0.504	0.873
1998	10.934	6.193	1.290	1.871	0.900	0.506	0.873
1999	10.974	6.193	1.337	1.871	0.908	0.508	0.873
2000	10.925	6.339	1.331	1.871	0.917	0.511	0.873
2001	11.068	6.356	1.247	1.871	0.949	0.511	0.873
2002	11.203	6.440	1.329	1.871	0.981	0.511	0.873
2003	11.337	6.492	1.338	1.870	1.014	0.511	0.873
2004	11.454	6.524	1.325	1.870	1.046	0.511	0.873
2005	11.571	6.684	1.297	1.870	1.078	0.511	0.873
2006	11.507	6.591	1.325	1.895	1.111	0.511	0.873
2007	11.442	6.559	1.323	1.922	1.143	0.511	0.873
2008	11.426	6.527	1.364	1.951	1.175	0.511	0.873
2009	11.388	6.475	1.389	1.984	1.175	0.511	0.873
2010	11.414	6.574	1.390	2.021	1.176	0.511	0.873
2011	11.445	6.508	1.443	2.061	1.176	0.511	0.873
2012	11.508	6.546	1.445	2.105	1.176	0.511	0.873
2013	11.507	6.508	1.437	2.074	1.172	0.510	0.873
2014	11.500	6.481	1.415	2.044	1.168	0.508	0.873
2015	11.497	6.444	1.409	2.015	1.165	0.507	0.873
2016	11.482	6.439	1.397	1.987	1.161	0.505	0.873
2017	11.473	6.417	1.402	1.960	1.157	0.503	0.873
2018	11.457	6.400	1.412	1.934	1.154	0.502	0.873
2019	11.464	6.408	1.418	1.908	1.150	0.500	0.873
2020	11.451	6.380	1.399	1.883	1.147	0.499	0.873
2021	11.444	6.384	1.363	1.859	1.143	0.497	0.873
2022	11.393	6.429	1.361	1.836	1.139	0.496	0.873
2023	11.386	6.429	1.357	1.836	1.139	0.496	0.873
2024	11.386	6.429	1.354	1.836	1.139	0.496	0.873

Particle emissions

Emission trends

Particle emissions are generated in manure management, harvesting and field preparation, storage and handling of agricultural crops and fertilizers and field burning of agricultural residues and have been included in the inventory since the submission in 2004. Figure 5.13 below presents the $PM_{2.5}$ emissions from manure management.

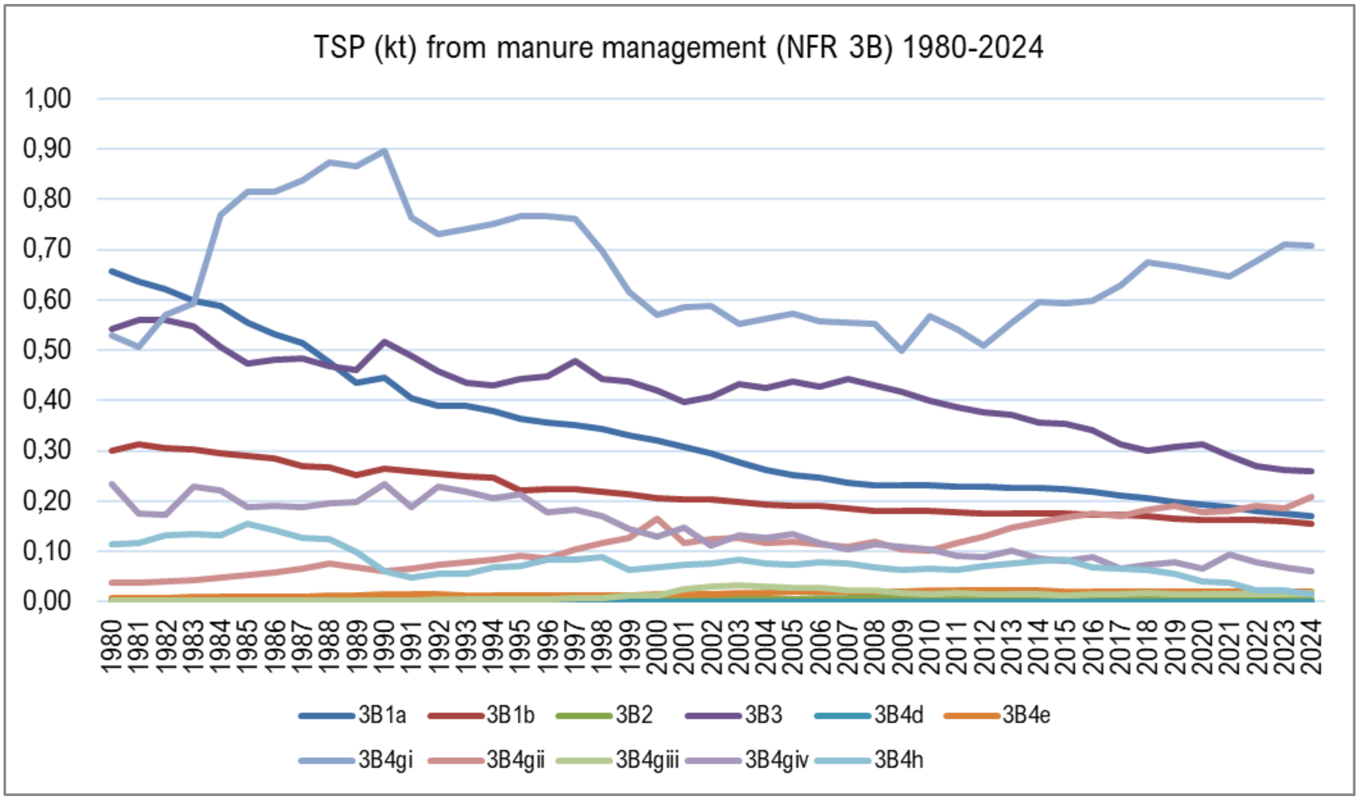


Figure 5.13 TSP emissions from NFR 3B categories 1990-2024.

According to the EMEP/EEA Guidebook, particle emissions occur from both housed and free-range animals while the emission factors presented are for housed animals only. The most important parameters impacting particle emissions are feeding conditions, animal activity and bedding material.

Methodological issues

The calculation of particulate matter emissions for manure management follows the Tier 2 method presented in EMEP/EEA Guidebook 2023 and is implemented as Equation below (particle emissions from animal husbandry for a single animal category) describes.

$$E_{PM\,i,j} = AAP_{i,j} * x_{i,j,house} * \sum \left(x_{mms,i,j} * EF_{mms,j} \right)$$

where

i	= Inventory year
j	= Animal category
E_{PM}	= PM emissions (TSP, PM_{10}, $PM_{2.5}$) for an animal category (in kg/a)
AAP	= Annual average population
x_{house}	= Share of time the animals spend in the animal house (in a/a)
x_{mms}	= Portion of manure that is handled as slurry, deep litter or solid manure.
EF	= Emission factor (kg AAP–1 a–1)

Emission factors are presented in Table 5.18. Livestock numbers for 1990-2024 are presented in Tables 5.15a-c.

Table 5.18a Tier 1 particle emission factors for animal husbandry (EMEP/EEA Guidebook 2023, Table 3-5) and portions of manure handled as slurry, deep litter, and solid manure per animal category for 2024.

Animal Category	Tier 1 Emission factor (kg AAP^{-1} a^{-1})			Portion of manure handled as:		
	TSP	PM10	$PM_{2.5}$	Slurry	Deep litter	Solid manure
Dairy cow	1.38	0.63	0.41	0.82	0.02	0.16
Suckler cow	0.59	0.27	0.18	0.03	0.50	0.47
Heifer >1 yr	0.59	0.27	0.18	0.51	0.22	0.27
Bull >1 yr	0.59	0.27	0.18	0.63	0.07	0.30
Calf <1 yr	0.34	0.16	0.1	0.25	0.29	0.47
Sow (with piglets)	0.62	0.17	0.01	0.86	0.08	0.07
Boar (50- kg)	0.62	0.17	0.01	0.95	0.01	0.05
Fattening pig (50- kg)	1.05	0.14	0.006	0.95	0.00	0.05
Weaned pig (20-50 kg)	0.27	0.05	0.002	0.96	0.01	0.03
Laying hen breeder (female)	0.19	0.04	0.003	0.01	0.15	0.85
Cockerel (laying hen breeder, male)	0.19	0.04	0.003	0.00	0.50	0.50
Broiler	0.04	0.02	0.002	0.00	1.00	0.00
Broiler breeder hen	0.04	0.02	0.002	0.00	1.00	0.00
Broiler breeder, male	0.04	0.02	0.002	0.00	1.00	0.00
Laying hen pullet	0.14	0.14	0.02	0.00	0.40	0.60
Turkey	0.11	0.11	0.02	0.00	1.00	0.00
Other poultry	0.14	0.14	0.02	0.00	0.40	0.60
Horse	0.48	0.22	0.14	0.00	0.13	0.87
Pony	0.48	0.22	0.14	0.00	0.13	0.87
Sheep	0.14	0.06	0.02	0.00	0.96	0.04
Goat	0.14	0.06	0.02	0.00	0.96	0.04
Fox and racoon	0.018	0.008	0.004	0.00	0.00	1.00
Mink and fitch	0.018	0.008	0.004	0.00	0.00	1.00

The parameter EF_{mms} of Equation 1 for technology specific emission factors are derived by applying the Tier 1 emission factor to the share of manure management systems present for each animal category with the assumption of slurry and deep litter systems having PM emission rates half of those in solid manure systems. This assumption is based on notes in the EMEP/EEA Guidebook 2023 section A1.2.1 for particulate matter.

Data on grazing times (grazing period in days), percentage of pastured animals, and indoor/outdoor times (% of pastured animals, animals inside in nights during grazing period, house inside in nights) presented in Table 5.19 were updated 2014 according to domestic studies (Grönroos et al., 2009/2014) for the years 2006-2012. Detailed information on these is available in Grönroos al., 2009/2014 for years the 1990, 1995, 2000 and 2005. The values for the year 1990 are used over the period of 1990-1994 and the year 1995 values over the period of 1996-1999 etc. The latest information for 2020 on grazing period of dairy cows and the share of pastured animals is based on the results of Agricultural Census 2020.

The parameters of Table 5.19 contribute to the formation of the parameter x_{house} of equation 1. The complete series of the share of time the animals spend in housing is presented in Table 5.20.

Table 5.19 Parameters by animal category in five-year intervals and in 2024: grazing times, percentage of pastured animals, and outdoor/ indoors times.

	Grazing times, grazing period (days)						
	1990	**1995**	**2000**	**2005**	**2015**	**2020**	**2024**
Dairy cows	125	125	125	125	115	119	121
Suckler cows	140	140	140	140	165	154	150
Bulls	0	0	0	0	178	205	216
Calves < 1 yr	100	100	100	100	130	135	137
Heifers >1 yr	140	140	140	140	136	140	141
Horses	140	140	140	140	180	180	180
Ponies	140	140	140	140	180	180	180
Sheep with lambs	140	130	130	130	149	142	139
Goat with gilts	140	130	130	130	149	142	139
Fattening pigs	0	0	0	0	0	0	0
Sows (with piglets)	90	0	0	0	0	0	0
Boars	90	0	0	0	0	0	0
Weaned pigs (20-50kg)	0	0	0	0	0	0	0
Reindeer	365	365	365	365	365	365	365

	Percentage of pastured animals (%)						
	1990	**1995**	**2000**	**2005**	**2015**	**2020**	**2024**
Dairy cows	90	90	90	90	65	58	50
Suckler cows	90	95	95	95	94	97	98
Bulls	0	0	0	0	7	4	3
Calves < 1 yr	30	25	25	25	28	21	19
Heifers >1 yr	95	90	90	90	66	58	54
Horses	95	95	95	95	97	97	97
Ponies	95	95	95	95	97	97	97
Sheep with lambs	95	90	90	90	92	96	98
Goat with gilts	95	90	90	90	92	96	98
Reindeer	100	100	100	100	100	100	100
	Animals inside in nights during grazing period (%)						
	1990	**1995**	**2000**	**2005**	**2015**	**2020**	**2024**
Dairy cows	60	75	90	100	100	100	100
	Hours inside in nights (hours)						
	1990	**1995**	**2000**	**2005**	**2015**	**2020**	**2024**
Dairy cows	12	12	12	12	11	12	12

Table 5.20 Share of time the animals spend in the animal house (in a/a) for animal categories, with annual variation.

Year	Dairy cow	Suckler cow	Heifer >1 yr	Bull >1 yr	Calf <1 yr	Sow (with piglets)	Horse	Pony	Sheep	Goat
1980	0.74	0.65	0.65	0.96	0.86	0.90	0.64	0.64	0.68	0.68
1981	0.74	0.65	0.65	0.96	0.87	0.91	0.64	0.64	0.68	0.68
1982	0.74	0.65	0.65	0.96	0.87	0.92	0.64	0.64	0.67	0.67
1983	0.74	0.65	0.65	0.96	0.88	0.93	0.64	0.64	0.67	0.67
1984	0.74	0.65	0.65	0.96	0.88	0.94	0.64	0.64	0.66	0.66
1985	0.74	0.65	0.65	0.96	0.89	0.95	0.64	0.64	0.66	0.66
1986	0.74	0.65	0.64	0.96	0.90	0.96	0.64	0.64	0.65	0.65
1987	0.74	0.65	0.64	0.96	0.90	0.97	0.64	0.64	0.65	0.65
1988	0.74	0.65	0.64	0.96	0.91	0.98	0.64	0.64	0.64	0.64
1989	0.74	0.65	0.64	0.96	0.91	0.99	0.64	0.64	0.64	0.64
1990	0.78	0.65	0.64	0.96	0.92	0.99	0.64	0.64	0.64	0.64
1991	0.79	0.65	0.64	0.96	0.92	0.99	0.64	0.64	0.64	0.64
1992	0.79	0.65	0.64	0.96	0.92	1.00	0.64	0.64	0.65	0.65
1993	0.80	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.66	0.66
1994	0.80	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.67	0.67
1995	0.81	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
1996	0.81	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
1997	0.82	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
1998	0.82	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
1999	0.83	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2000	0.83	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2001	0.83	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2002	0.84	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2003	0.84	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2004	0.84	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2005	0.85	0.64	0.65	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2006	0.85	0.63	0.67	0.96	0.93	1.00	0.64	0.64	0.68	0.68
2007	0.86	0.62	0.68	0.96	0.92	1.00	0.64	0.64	0.67	0.67
2008	0.86l	0.61	0.70	0.96	0.92	1.00	0.64	0.64	0.67	0.67
2009	0.87	0.61	0.71	0.96	0.91	1.00	0.64	0.64	0.67	0.67
2010	0.87	0.60	0.73	0.96	0.91	1.00	0.64	0.64	0.66	0.66
2011	0.88	0.59	0.74	0.96	0.90	1.00	0.64	0.64	0.66	0.66
2012	0.88	0.58	0.76	0.96	0.90	1.00	0.64	0.64	0.65	0.65
2013	0.88	0.59	0.76	0.96	0.90	1.00	0.64	0.64	0.65	0.65
2014	0.89	0.59	0.77	0.97	0.91	1.00	0.64	0.64	0.65	0.65
2015	0.89	0.59	0.77	0.97	0.91	1.00	0.64	0.64	0.65	0.65
2016	0.89	0.60	0.78	0.97	0.91	1.00	0.64	0.64	0.65	0.65
2017	0.90	0.60	0.78	0.97	0.92	1.00	0.64	0.64	0.65	0.65
2018	0.90	0.60	0.79	0.98	0.92	1.00	0.64	0.64	0.65	0.65
2019	0.90	0.60	0.79	0.98	0.93	1.00	0.64	0.64	0.65	0.65
2020	0.91	0.61	0.79	0.98	0.93	1.00	0.64	0.64	0.65	0.65
2021	0.91	0.61	0.80	0.98	0.93	1.00	0.64	0.64	0.65	0.65
2022	0.92	0.61	0.80	0.99	0.94	1.00	0.64	0.64	0.65	0.65
2023	0.92	0.61	0.80	0.99	0.94	1.00	0.64	0.64	0.65	0.65
2024	0.92	0.61	0.80	0.99	0.94	1.00	0.64	0.64	0.65	0.65

Fur animals and poultry are considered to stay always indoors (x_{house} = 1) and reindeer always outdoors (x_{house} = 0).

NMVOC emissions

Emission trends

Emissions of NMVOC in manure management originate from silage store and feed, manure in the barns, outdoor manure stores, field application of manure and grazing of livestock. In-house emissions are reported under NFR 3B (Figure 5.14) and emissions of field application of manure and grazing under NFRs 3Da2a and 3Da3, respectively.

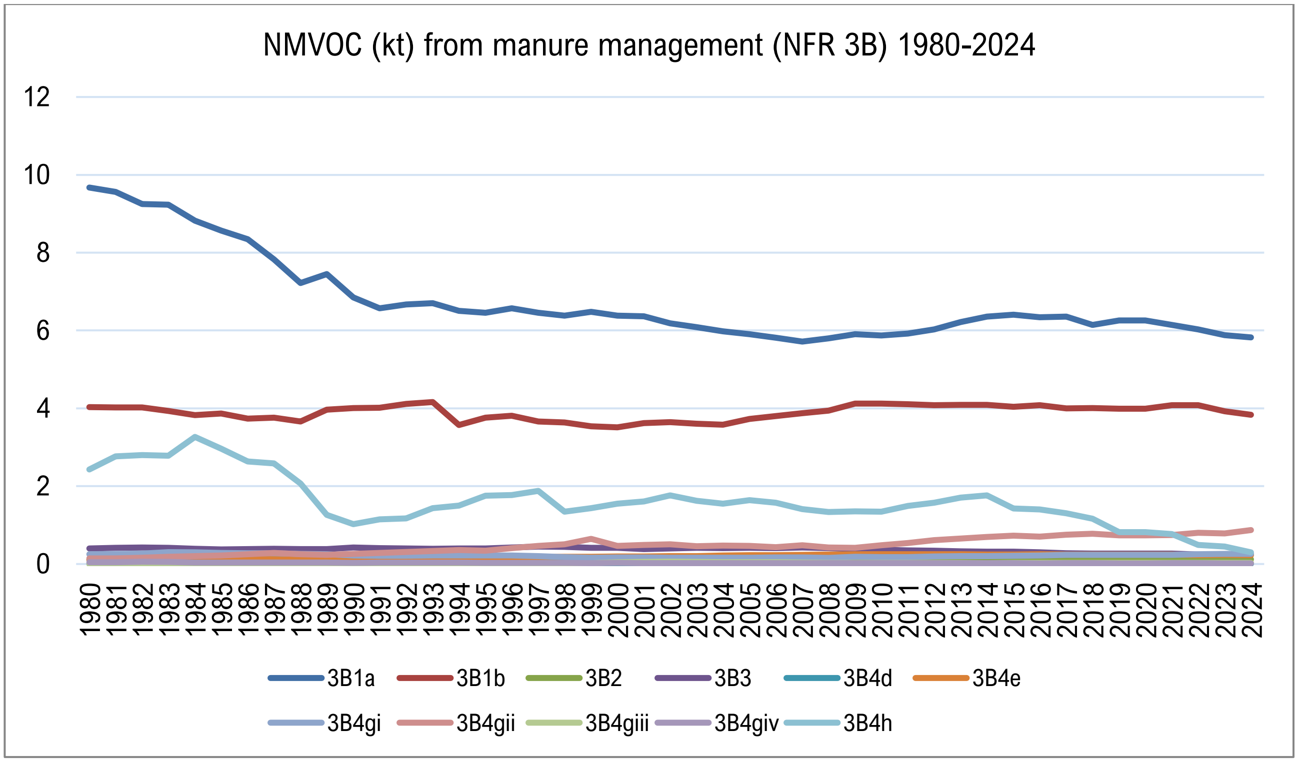


Figure 5.14 NMVOC emissions from NFR 3B categories 1980-2024.

Methodological issues

The calculation method for NMVOC emissions is presented in detail in Grönroos et al., 2017 (in the reporting folder).

The main parameters for calculation are gross energy intake (GEI as megajoules MJ/a), volatile solids excreted (VS), and annual average population (AAP) which are provided by Natural Resources Institute Finland (Luke). Parameters such as the share of time animals spend in housing (Table 5.20) and the proportion of silage as a fraction of the maximum proportion of silage (Table 5.21) are national values. Data is available for GEI and VS for the years 1990-2024 and for AAP for the years 1980-2024. The livestock classification varies between the data sources. Gross energy intake (Table 5.22) is available for dairy cows, non-dairy cattle, suckler cows, bulls (age over 1 year), heifers, calves (under 1 year) and non-dairy gross energy. Data of gross energy intakes as required by the EF of cattle are presented in Table 5.22. For VS (Table 5.23), primary data is available for dairy cows, non-dairy cattle, suckler cows, bulls (age over 1 year), heifers, calves (under 1 year), swine, sow, piglets, fattening pigs, boars, weaned pigs, sheep, goats, horses, poultry, laying hens, laying hen pullets, cockerels, broiler hens, broilers, turkeys, other poultry (ducks), other animals, reindeer, fur animals, mink and fitch, fox and raccoon.

Emission factors from EMEP/EAA Guidebook 2023 are presented in Table 5.24.

To accommodate the emission factors to the categorization of livestock in the Finnish Normative Manure system, the following applications are made:

- Heifers: emission factor of dairy cattle applied
- Bulls: emission factor of dairy cattle applied
- Calves: emission factor of dairy cattle applied
- Weaned pig (20-50kg): emission factor of swine (fattening pigs)

Table 5.21 Proportion of silage as a fraction of the maximum proportion of silage.

Animal category	Fracsilage	Animal category	Fracsilage
Dairy cow	0.56	Laying hen pullet	0
Suckler cow	1	Turkey	0
Heifer >1 yr	0.7	Other poultry	0
Bull >1 yr	0.61	Horse	0.375
Calf <1 yr	0	Pony	0.375
Sow (with piglets)	0	Sheep	0.68
Boar (50- kg)	0	Goat	0.67
Fattening pig (50- kg)	0	Fox and racoon	0
Weaned pig (20-50 kg)	0	Mink and fitch	0
Laying hen breeder (female)	0	Reindeer	0
Cockerel (laying hen breeder, male)	0	Broiler breeder hen	0
Broiler	0	Broiler breeder. male	0

Table 5.22 Gross energy intake (MJ/head/day) in five-year intervals 1980-2020 and the inventory year 2024.

Livestock	1980	1985	1990	1995	2000	2005	2010	2015	2020	2024
Dairy cows	244.75	252.10	257.83	270.08	290.44	307.82	322.85	345.73	370.12	380.51
Suckler cows	164.30	165.44	166.99	166.79	164.79	169.68	174.10	178.31	186.43	183.90
Bulls (age over 1 year)	127.14	129.90	132.29	134.99	137.71	152.67	160.03	159.43	168.24	164.34
Heifers	118.87	120.67	121.96	125.14	129.27	134.61	138.25	144.08	152.57	151.32
Calves (under 1 year)	73.14	76.14	77.00	73.31	79.65	84.55	86.15	87.12	91.15	89.27
Non-dairy GE	95.57	97.67	99.24	101.27	105.96	113.82	120.46	122.17	128.39	127.24

Table 5.23 Volatile solids (VS) excreted in five-year intervals 1980-2020 and the inventory year 2024 (kg/head/day).

Animal category	1980	1985	1990	1995	2000	2005	2010	2015	2020	2024
Dairy cows	4.35	4.44	4.52	4.71	4.93	5.07	5.26	5.88	6.33	6.54
Non-dairy cattle	1.61	1.63	1.65	1.69	1.75	1.83	1.94	1.98	2.04	2.04
Suckler cows	3.33	3.33	3.35	3.28	3.18	3.22	3.24	3.32	3.48	3.43
Bulls (age over 1 year)	2.08	2.11	2.14	2.18	2.20	2.36	2.47	2.47	2.54	2.53
Heifers	2.21	2.24	2.26	2.29	2.34	2.39	2.45	2.59	2.70	2.68
Calves (under 1 year)	1.17	1.18	1.18	1.18	1.20	1.23	1.23	1.23	1.24	1.23
Swine	0.22	0.22	0.22	0.21	0.22	0.22	0.22	0.21	0.21	0.20
Sow	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Piglets	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fattening pigs	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Boars	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Weaned pigs	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Sheep	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Goats	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Horses	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13
Poultry	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Laying hens	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Laying hen pullet	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cockerels	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Broiler hens	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Broilers	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Turkeys	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Other poultry (ducks)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Other animals										
Reindeer	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Fur animals	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Mink and fitch	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Fox and racoon	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14

Table 5.24 Default NMVOC Tier 2 emission factors for livestock (EMEP/EAA Guidebook 2023).

NFR	Animal category	$EF_{silage\_feeding}$	EF_{house}	$EF_{grazing}$	Unit
3B1a	Dairy cattle	2.00E-04	3.53E-05	6.90E-06	kg NMVOC kg/MJ feed
3B1b	Non-dairy cattle	2.00E-04	3.53E-05	6.90E-06	kg NMVOC kg/MJ feed
3B2	Sheep	1.08E-02	1.61E-03	2.35E-05	kg NMVOC/kg VS excreted
3B3	Swine (fattening pigs)	1.70E-03			kg NMVOC/kg VS excreted
3B3	Swine (sows)		7.04E-03		kg NMVOC/kg VS excreted
3B4a	Buffalo	1.08E-02	1.61E-03	2.35E-05	kg NMVOC/kg VS excreted
3B4d	Goats	1.08E-02	1.61E-03	2.35E-05	kg NMVOC/kg VS excreted
3B4e	Horses	1.08E-02	1.61E-03	2.35E-05	kg NMVOC/kg VS excreted
3B4f	Mules and Asses	1.08E-02	1.61E-03	2.35E-05	kg NMVOC/kg VS excreted
3B4gi	Laying hens	5.68E-03			kg NMVOC/kg VS excreted
3B4gii	Broilers	9.15E-03			kg NMVOC/kg VS excreted
3B4giii	Turkeys		5.68E-03		kg NMVOC/kg VS excreted
3B4giv	Other poultry (ducks, geese)	5.68E-03			kg NMVOC/kg VS excreted
3B4h	Other animals (fur animals)	5.68E-03			kg NMVOC/kg VS excreted
3B4h	Other animals (rabbits)	1.61E-03			kg NMVOC/kg VS excreted
3B4h	Other animals (reindeer)	1.61E-03	2.35E-05		kg NMVOC/kg VS excreted

Emissions are calculated separately for silage store and feeding, housing, manure storage and field application of manure. The emissions are calculated for every animal category with annually calculated parameters (where available). In each activity, emissions are calculated for the count of one animal. The animal and year specific emissions are then multiplied by the average annual population. The corresponding equation is presented below.

$$E_{NMVOC\,i,j} = AAP_{i,j} * \left(E_{silage_{store}} + E_{silage_{feed}} + E_{house} + E_{manure_{storage}} + E_{manure_{application}} + E_{grazing}\right)_{i,j}$$

Where,

i	= Livestock category
j	= Inventory year
$AAP_{i,j}$	= Annual average population within the animal category in the given year
$E_{silage_{store}}$	= Emissions from silage store
$E_{silage_{feed}}$	= Emissions from silage feeding
E_{house}	= Emissions from housing
$E_{manure_{storage}}$	= Emissions from manure in barns and outside stores
$E_{manure_{application}}$	= Emissions from field application of manure (reported under 3Da2a)
$E_{grazing}$	= Emissions from grazing (reported under 3Da3)

Emissions from housing are estimated based on the time that the livestock spends in buildings, which is estimated annually. The estimates are retrieved from the Finnish Normative Manure System. The emission values are calculated with equations presented below.

Cattle:

$$E_{house} = MJ_i * X_{house_i} * EF_{house_i}$$

Other livestock:

$$E_{house} = VS_i * X_{house_i} * EF_{house_i}$$

Where,

i	= Livestock category
MJ_i	= Gross feed intake as (MJ/a)
VS_i	= Volatile solids excreted (kg/a)
X_{house_i}	= Annual proportion of time the livestock spends inside buildings (%)
EF_{house_i}	= Emission factor for emissions from housing

Emissions from silage store are estimated based on the time that the livestock spends in buildings (see Table 5.20 for the applied rates) and by estimating the fraction of silage feeding in the given livestock category. To apply the formula, it is to be assumed that silage feeding always occurs inside livestock buildings.

Cattle:

$$E_{silage_{store}} = MJ_i * X_{house_i} * \left(EF_{silage_{feed}} * Frac_{silage}\right)_i$$

Other livestock:

$$E_{silage_{store}} = VS_i * X_{house_i} * \left(EF_{silage_{feed}} * Frac_{silage}\right)_i$$

Where,

i	= Animal category

$EF_{silage_{feed}}$	= Emission factor for silage feed
$Frac_{silage}$	= Proportion of silage as feed (%)

Emissions from silage store are estimated as the share of stored silage in relation to silage in the feeding table by introducing an estimate of the fraction of the stored silage to equations below.

Cattle:

$$\boldsymbol{E_{silage_{store}} = MJ_i * X_{house_i} * \left(EF_{silage_{feed}} * Frac_{silage} * Frac_{silage_{store}}\right)_i}$$

Other livestock:

$$\boldsymbol{E_{silage_{store}} = VS_i * X_{house_i} * \left(EF_{silage_{feed}} * Frac_{silage} * Frac_{silage_{store}}\right)_i}$$

Where,

i	= Animal category
$Frac_{silage_{store}}$	= The relative share of stored silage in relation to silage in feeding table (%)

The EMEP/EEA 2023 Guidebook default for $Frac_{silage_{store}}$ of 0.25 is used for all species and all years. Emission factors of silage feeding, however, are not cross-applied between the species except for categories with close resemblance to each other. The model suggests emissions from silage store to occur on all cattle, horses, sheep and goats.

<u>Manure storage</u>

The proportion of emissions from storage is assumed to possess the same ratio as with ammonia. The equation only factorizes NMVOC emissions from housing with the storage/building-ratio of ammonia emissions. Ammonia emissions are calculated in the Finnish Normative Manure System.

$$\boldsymbol{E_{manure_{storage}} = E_{NMVOC_{house}} * \left(\frac{E_{NH3_{storage}}}{E_{NH3_{building}}}\right)_i}$$

Where,

i	= Livestock category
$E_{NMVOC_{house}}$	= NMVOC emissions from housing
$E_{NH3_{storage}}$	= Ammonia emissions from storage
$E_{NH3_{building}}$	= Ammonia emissions from housing

Uncertainty and time series' consistency

The time series is consistent. The results of the uncertainty analysis are provided in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checks related to the assessment of magnitude and trends have been carried out. A nitrogen flow checking tool has been added to the emission calculation of nitrogen compounds to verify that the mass balance calculation of manure-related nitrogen emissions is working as it should. At present, no verification has been carried out for the specific source-sector emissions. Cross-checking of data and functions of the model are carried out as the same model is used both by Syke for air pollutant emissions inventories and by Luke for greenhouse gas emissions inventories.

Source-specific recalculations including changes made in response to the review process

2011

- The allocation of boars was changed from NFR 4B13 to 4B8.
- NH_3 and particle emissions were recalculated and reported in NFR format.

2013

- The time series 1990-2013 was recalculated and reported in NFR14 format.

2014

- Revision of ammonia emission factors and disaggregation of activity data in cooperation with the Natural Resources Institute Finland.

2015

- Particulate matter emission factors for manure management revised according to EMEP/EEA Guidebook 2013 for the whole time series. Also, data on grazing times, manure handling systems and indoor/outdoor times were updated according to domestic studies.

2017

- Particle emissions from heifers were inserted in the time series as they were missing due to an error from inventory submissions in 2010-2014.

2016-2017

- The Finnish Agriculture Emissions Calculation Model was completed with NMVOC emissions according to the method presented in the 2016 EMEP/EEA Guidebook. (Grönroos et al., 2017)
- The calculation of NH_3 and NOx emissions was revised (Grönroos et al, 2017)

2019

- Particulate matter emissions were included for goats, sheep, fur animals and reindeer based on EMEP/EEA Guidebook 2016
- The implied emission factors for NH_3 have changed from the previous reporting because of the correction of the error in emission calculation of deep litter manure system. The emissions (NH_3, NO, N_2O) from spreading of 80% of the manure managed as deep litter were missing because of an error in the calculation sheets of all other animals than broilers.

2020

- New Tier 2 ammonia emission factors of the EMEP/EEA Guidebook 2019 were introduced for manure management, manure spreading and grazing, replacing the Tier 2 emission factors of EMEP/EEA Guidebook 2016.
- Nitrogen excretion factors time series (1990-2018) of suckler cows and dairy cows were updated due to the changes in excretion calculation methods. Nitrogen excretion of suckler cows was recalculated to better reflect the change in their diet that has taken place along the time series. A double counting error in dairy cow N excretion was corrected: the increased energy demand during the first pregnancy was removed from dairy cows, since it is already included in the heifer stage.
- Nitrogen excretion factor of horses was corrected for 2017.

- Numbers of fur animals were updated for the years 2016 and 2017. A technical error in the calculation of particle emissions for manure management for the early years of the time series corrected.
- A technical error in the calculation of particle emissions for manure management for the early years of the time series corrected.

2021

- Nitrogen excretion factor time series (1990-2019) for sheep was corrected based on the new data provided by the Natural Resources Institute Finland (Luke).
- Nitrogen excretion factor of Turkey for 2018 was corrected.
- Minor changes to the numbers of calves (year 2015) and foxes (year 2011) were done.
- The number of Reindeer for 2015 was corrected.

2022

Technical updates:

- For each manure type of each animal category, the possibility to report the proportion of manure going to anaerobic digestion was added to the calculation system. Based on this information, part of the manure nitrogen is directed to the biogas plant emission calculation section added to the calculation system. A return route was added to the system for manure from the biogas plant emission calculation section back to the normal manure calculation, where the changed properties of manure are taken into account in the further calculation (manure application emission calculation) according to the calculation guidelines.
    - Sheep, horses and fur animals do not produce slurry. However, after anaerobic treatment, digestate (as slurry) return to those farms to be applied on fields. For them, the slurry application data are assumed to be the same as for cattle.
- Additionally, calculation of the emissions from anaerobic digestion of other organic wastes (than manure) and of energy crops was also added to the biogas plant emission calculation section.
- In the same context, as a continuation of the above calculation, a section was built in which emissions from the application of the organic wastes other than manure can be calculated. In addition to the digested materials, composted and untreated materials (potato cell fluid, meat and bone meal) are also taken into account.
    - In the calculation of emissions from the application of digested and composted wastes (other than manure), there is uncertainty as to which part of these materials are applied to the fields and which part go to landscaping, for example.
- Manure management emission calculation system was supplemented by the possibility to use a separate evaporation factor for each modeled animal category (e.g. sows, fattening pigs) instead of using the same factor for the group of animals (e.g. pigs). In practice, this change affected the calculated emissions of cattle, pigs, and poultry.
- In the previous version of the calculation system, it was supposed that only dung is collected and removed from the yards. In the updated version it is supposed that also urine is collected, as instructed in the emission calculation guidelines.
- An error in the deep litter calculation (did not consider the abatement measures) was corrected, and an incorrect temperature factor for deep litter housing was also rectified.
- The emission abatement factor for increased manure removal frequency for poultry solid manure was corrected (10% => 50%).

Activity data updates:

- Coverage of emission abatement measures in poultry animal shelters: increasing the share of non-leaking drinking equipment to 100% in broilers and turkeys, increasing the frequency of compacted manure removal to 95% in laying hens (in 2020, also corrected for the entire time series).
- For fur animals, the statistics on annually sold pelts is normally used as a source for animal numbers. However, for 2019 and 2020 the statistics showed exceptionally low volumes. For this reason, an exceptional method was used to derive the number of pelts produced from the cub production statistics using a long-term pelt / cub ratio.
- Some results from Agricultural Census 2020 were available:
    - data on cattle grazing
    - dairy cattle in slurry system divided into different housing systems (tied stall, loose warm, semi warm and cold)
    - share of deep litter manure management systems in laying hens rearing (decreased)
    - share of covered poultry solid manure storages (increased).

2023

- As was mentioned in the previous reporting, the statistics on annually sold pelts has been used as a source of fur animal numbers but they have showed unexceptionally low volumes for 2019 and beyond. Due to this, the whole time series of fur animal numbers was updated to be based on the numbers of produced cubs.
  For the years 1980-1989 there were no statistics of the numbers of cubs. For those years, cub/pelt ratio of the beginning of 1990s (1.1 for foxes and 1.04 for minks) was used to convert numbers of pelts to numbers of cubs.
- Nitrogen excretion rates of sheep for the years 2019 and 2020 and cattle for the years 2019-2021 were corrected based on the data provided by Luke in Autumn 2022.
- Number of sheep for the year 2020 was corrected from 149 171 to 140 171.
- Number of reindeer for the year 2020 was corrected from 188 190 to 194 972.
- Nearly the entire time series of NH_3, NOx and NMVOC emissions from horses were recalculated due to an error in the calculation system.

2024

- Calculation of NH_3 emissions from the biological treatment of waste by anaerobic digestion at biogas facilities has been fixed to also consider the manure that is removed from dry lots (erroneously included only the manure managed inhouse). This slightly alters the results (for entire time series) for animals where a portion of the manure ends up in the dry lot.
- The deep litter calculation has been enhanced to include the deep litter manure directed to anaerobic digestion, which is now calculated from both the stored manure and the manure applied after removal from the animal house. In the previous version, the share was computed solely from the stored manure. This change impacts all other emission compounds except particles.
- The entire time series (from 1990) of N excretion rates of sheep was updated based on the new data from Natural Resources Institute Finland (Luke). Additionally, numbers of pigs for the year 2021 (total number of pigs didn't change), and the N excretion value of sows for 2021 have been updated, both based on the new data from Luke. These changes impact all other emission compounds except particles.
- Excretion (N (separately for urine and faeces), VS) time series of all cattle categories have been updated based on the new data from Luke. Luke has renewed its excretion calculation system, and the new values (like all other activity data related data obtained from Luke) are used also in GHG emission inventory. Additionally, cattle gross energy values have been updated as well. While cattle excretion values for 1990-2022 are from Luke, for the previous years (1980-1989) the existing excretion values have been corrected using a ratio between

new and old excretion rate for 1990. These changes impact all other emission compounds except particles.

- A nitrogen flow checking tool was added to the agricultural emission calculation system to verify that the mass balance calculation of manure-related nitrogen emissions is working as expected.

2025

- A survey (carried out by the Natural Resources Institute Finland, Luke) on manure management practices was sent to farmers in 2022, and the results were available for the 2025 reporting. However, due to a low response rate, the survey did not provide sufficient information on certain aspects and animal categories. Therefore, data from the Agricultural Census 2020 were used when deemed a better alternative. A new interpolation between the years 2012 and 2022 was done due to the new data. These changes impact all emission compounds.
    - cattle and pig slurry covering data was obtained from the Agricultural Census 2020
    - most recent data on pasturing was obtained from the Agricultural Census 2020
    - most recent data on dry lots was obtained from the results of 2022 manure management survey.
- IPCC 2006 N_2O-emission factors were replaced with IPCC 2019 emission factors (manure management, nitrogen additions to soil). These changes impact slightly emissions of all nitrogen compounds and NMVOC.
- For storing of urine and slurry, a same N_2O emission factor (0.5%) is used for all covered manure (previously EF 0.5% was used only for manure covered with natural crust and floating covers). These changes impact slightly emissions of all nitrogen compounds and NMVOC.
- For the 2025 reporting, the entire nitrogen excretion time series (1980–2023) for pigs, horses, and ponies was updated using new excretion values calculated by the Natural Resources Institute Finland (Luke). These changes impact all other emission compounds except particles.
- Excretion data on GE and VS for 2023 were updated based on new data from Natural Resources Institute Finland, Luke. For non-dairy and calves, the entire time series of GE and VS was updated. These changes impact only NMVOC emissions.
- The numbers of sows in 2009, horses and ponies in 2023, fur animals in 1998 and 2010, and broiler hens and turkeys in 2021 were adjusted. These changes impact all emission compounds.
- Calculation of N_2O emissions from dry lots was corrected to use the correct N_2O emission factor. This change impacts slightly emissions of all nitrogen compounds and NMVOC.
- Calculation of N_2O emissions was corrected to use the correct total nitrogen value. This change impact slightly emissions of all nitrogen compounds and NMVOC.
- Slight adjustments to nitrogen excretion values of poultry were made, mainly for 2017 and 2018. These changes impact all other emission compounds except particles.
- N_2O emission calculation was adjusted to apply the same EF for poultry manure without litter (0.001) also for slurry. Calculation is now done for all stored manure, not only for covered manure. This change impacts slightly emissions of all nitrogen compounds and NMVOC.

2026

- The numbers of bulls and pigs in 2022, and pigs, laying hens and cockerels in 2023 were adjusted. These changes impact all emission compounds.

Source-specific planned improvements

The entire agricultural emission calculation system will be migrated from Excel to the R environment during 2026.

5.5 Agricultural Soils (NFR 3D)

Figure 5.15 K. Inha (1899)

Source category description

Changes in chapter	
February 2026	JG, JM, TF

The category covers emission sources presented in Table 5.25.

Table 5.25 Emission sources and emissions reported under NFR 3D.

NFR		Emissions
3Da1	Inorganic N-fertilizers	NOx, , NH_3
3Da2a	Animal manure applied to soils	NOx, NMVOC, NH_3 (calculated in 3B)
3Da2b	Sewage sludge applied to soils	NH_3, NOx
3Da2c	Other organic fertilisers applied to soils	NH_3, NOx
3Da3	Urine and dung deposited by grazing livestock	NOx, NMVOC, NH_3 (calculated in 3B)
3Da4	Crop residues applied to soils	NH_3
3Db	Indirect emissions from managed soils	
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP, PM10, PM2.5
3Dd	Off-farm storage, handling and transport of bulk agricultural	NA
3De	Cultivated crops	NMVOC
3Df	Use of pesticides	HCB
3F	Field burning of agricultural residues	NOx, NMVOC, SOx, CO, NH_3, particles, heavy metals, PCDD/F, PAH-4
3I	Agriculture other	NO

5.5.1 Synthetic N-fertilizers (NFR 3Da1)

Changes in chapter	
February 2026	JG, JM, TF

Source category description

Nitrogen oxides and ammonia emissions from the use of synthetic nitrogen fertilizers are included under this category.

Emission trend

The emission trend fluctuates according to the use of fertilizers (Figure 5.16).

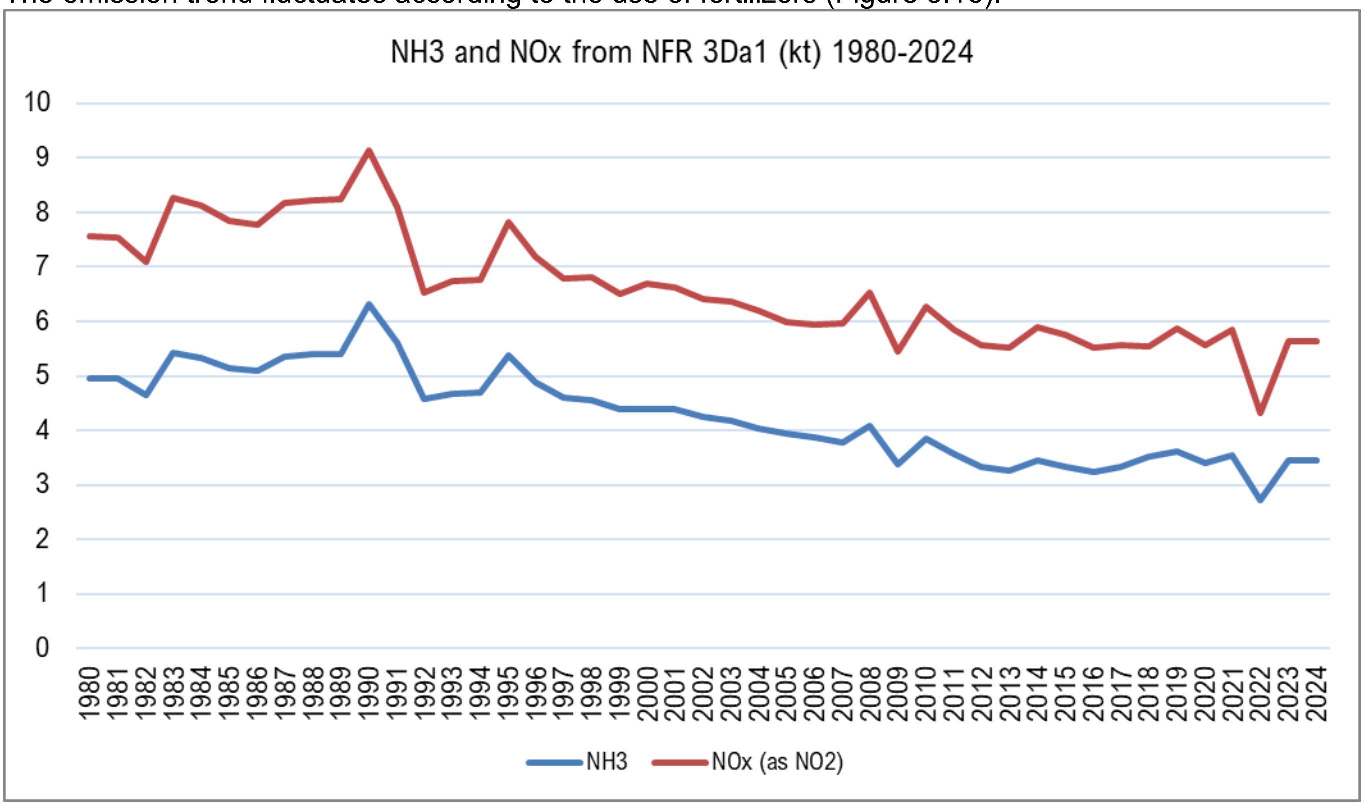


Figure 5.16 NH_3 *and NOx emissions 1980-2024 from the use of synthetic N-fertilisers*

Methodological issues

Ammonia emissions

Calculation of NH_3 emissions from application of nitrogen fertilizers is carried out in the agriculture emissions calculation model (Grönroos et al. 2017). The calculation is consistent with the EMEP/EEA Guidebook 2023.

Ammonia emissions from the use of mineral N-fertilisers were calculated separately for different fertiliser types using the emission factors presented in the EMEP/EEA Guidebook 2023 (Table 3-2). Due to the low soil pH in Finland, the 'normal pH' emission factors were applied (Table 5.26). The total amount of nitrogen sold annually in Finland (Table 5.27) was divided over fertiliser types using the information provided by the Finland's NID 2026 (Table 5.28). The EMEP/EEA emission factors presented in Table 5.26 are based on the emissions from surface applied fertilisers. In Finland, however, placement fertilisation is typically used for cereals. According to the EMEP/EEA Guidebook 2019 (A1.2.2), fertiliser-N that is immediately incorporated into the soil will not be a source of ammonia as the NH_4^+ ions are absorbed onto soil colloids or nitrified. Thus, N-fertilisers used in Finland have been divided between fertilisers spread using placement fertilisation and fertilisers applied on soil surface (typically grassland).

The proportion of placement fertilisation (65%) is based on the ratio between non-grasses and the total actively cultivated agricultural land. For grasses, mineral fertilisers are typically applied by broadcast spreading technique, and for other crops the placement fertilisation technique is used. Between the years 1980 and 2024, the proportion of other than grasses has varied between 58 and 69 percent, being averagely 65% (See Table 5.29).

Table 5.26. Distribution of mineral N-fertilisers used in Finland by fertiliser type (%) in 2024, distribution of each fertiliser type by application method (placement fertilisation or spread on soil surface, %), and ammonia emission factors (EFs for normal pH) for different fertiliser types applied. Data for 2024 are the same as for 2023 because no new data were available.

Spread as:	**% of applied fertiliser-N**	**Spread using placement fertilisation (%)**	**Spread on soil surface (%)**	**EF for fertiliser-N spread on soil surface (kg NH_3 kg^{-1} N)**
Ammonium nitrate	0.00 %	65	35	0.024
Anhydrous ammonia	0.00 %	65	35	0.021
Ammonium phosphates	0.21 %	65	35	0.084
Ammonium sulphate	0.20 %	65	35	0.084
Calcium ammonium nitrate	29.23 %	65	35	0.024
Calcium nitrate	0.05 %	65	35	0.084
Ammonium solutions (AN)	0.03 %	65	35	0.024
Ammonium solutions (Urea AN)	0.00 %	65	35	0.087
Urea ammonium sulphate	0.00 %	65	35	0.098*
Urea	3.70 %	65	35	0.195
Other NK and NPK	66.58 %	65	35	0.084

** No Ef for this in GB 2023, the old factor is used instead.*

Table 5.27. Use of mineral N-fertilizers as N (tonnes) 1980-2024.

Year	Use of N-fertlizers (t)	Year	Use of N-fertlizers (t)	Year	Use of N-fertlizers (t)
1980	189 098	2000	167 276	2020	139 316
1981	188 457	2001	165 621	2021	145 807
1982	177 234	2002	160 403	2022	108 044
1983	206 665	2003	159 288	2023	140 924
1984	202 814	2004	154 708	2024	140 924*
1985	196 242	2005	149 562		
1986	194 304	2006	148 161		
1987	204 140	2007	148 784		
1988	205 674	2008	162 905		
1989	205 862	2009	136 009		
1990	228 470	2010	156 523		
1991	202 462	2011	146 189		
1992	163 229	2012	138 900		
1993	168 199	2013	138 136		
1994	169 138	2014	147 373		
1995	195 460	2015	143 479		
1996	179 529	2016	138 128		
1997	169 345	2017	138 948		
1998	169 928	2018	138 385		
1999	162 700	2019	146 798		

** No data available yet for 2024, same as for 2023*

Table 5.28 Distribution of mineral N-fertilisers used in Finland by fertiliser type. The share of each fertiliser depends on the year (Sources: Kemira / Yara Finland and Finnish Food Safety Authority Evira / Finnish Food Authority) (Finland's NID 2026). Data for 2024 is the same as for 2023 because no new data was available.

Fertiliser type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
Ammonium sulphate	0.004	0.0	0.0	0.0	0.2	0.4	0.6	0.2	0.2	0.7	0.7
Ammonium nitrate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calcium ammonium nitrate	10.8	9.3	15.3	15.2	23.8	30.9	24.6	25.4	25.0	30.6	30.6
Anhydrous ammonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Urea	1.3	0.1	0.2	0.4	0.5	0.8	0.7	0.5	2.6	3.8	3.8
Nitrogen solutions	0.003	0.0	0.0	0.02	0.02	0.0	0.2	0.1	0.1	0.1	0.1
Ammonium phosphates	0.1	0.1	0.1	0.2	0.2	0.2	0.0	0.0	0.2	0.4	0.4
Other NK and NPK	87.5	90.3	84.3	84.2	75.3	67.6	74.0	73.8	71.8	64.5	64.5
Nitrate only	0.3	0.09	0.08	0.06	0.06	0.07	0.0	0.0	0.1	0.0	0.0

Table 5.29. The proportion of other crops than grasses of the total cultivated area, excluding fallows, between the years 1980 and 2024.

Year	All crops, 1000 ha (without fallow)	Other than grasses (1000 ha)	Proportion of other than grasses (= placement fertilisation-%)
1980	2269.7	1318.3	58 %
1981	2288.2	1362.6	60 %
1982	2253.5	1327.3	59 %
1983	2262.0	1381.6	61 %
1984	2229.8	1386.1	62 %
1985	2206.7	1402.6	64 %
1986	2157.7	1374.7	64 %
1987	2162.9	1436.8	66 %
1988	2094.3	1402.0	67 %
1989	2051.5	1366.6	67 %
1990	2088.2	1406.3	67 %
1991	1808.0	1184.9	66 %
1992	1758.0	1096.8	62 %
1993	1784.0	1097.4	62 %
1994	1796.8	1112.5	62 %
1995	1918.1	1163.5	61 %
1996	1942.9	1240.7	64 %
1997	1963.6	1277.1	65 %
1998	1999.8	1318.2	66 %
1999	1965.2	1293.8	66 %
2000	2005.7	1318.7	66 %
2001	1990.0	1325.3	67 %
2002	1992.9	1355.2	68 %
2003	1991.7	1362.3	68 %
2004	2022.9	1402.9	69 %
2005	1993.4	1373.2	69 %
2006	2005.4	1380.7	69 %
2007	2023.8	1370.0	68 %
2008	2068.9	1413.6	68 %
2009	2026.8	1386.3	68 %
2010	1946.3	1287.2	66 %
2011	1973.3	1306.5	66 %
2012	1980.5	1320.6	67 %
2013	1969.1	1319.6	67 %
2014	1982.8	1330.7	67 %
2015	1969.6	1317.1	67 %
2016	1983.0	1295.4	65 %
2017	1988.3	1271.4	64 %
2018	1996.4	1235.5	62 %
2019	2022.7	1236.6	61 %
2020	2035.5	1254.9	62 %
2021	2030.2	1228.2	60 %
2022	2033.4	1237.8	61 %
2023	2022.6	1236.7	61 %
2024	1995.0	1204.0	60 %

Nitrogen dioxide emissions

Nitric oxide emissions expressed as nitrogen dioxide (NO_2) were included to the inventory for first time in the 2017 submission for the whole time series (1990-2016). The calculation is carried out in the Agriculture Emissions Calculation Model (Grönroos et al., 2017). The model is described in more detail above (ammonia emissions), nitric oxide emissions are calculated in the model as part of other nitrogen emissions. For nitrogen dioxide, the emission factor of 0.04 kg NO_2 kg^{-1} fertiliser-N applied (EMEP/EEA 2023) was used.

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2018
- The emission factor for NO_x emissions from NFR 3Da1 was updated to the 2018 submission.

2020
- Distribution of mineral N-fertilisers used in Finland by fertiliser type for the years 2015-2017 was corrected to the 2020 submission.

2024
- The new NH_3 emission factors in accordance with the EMEP/EEA Guidebook 2023 were implemented, and the entire time series was recalculated.
- NOx emission value recalculated for the year 2021.

2025
- The use of mineral N fertilisers for 2022 was corrected because statistical data was not available during the previous reporting. For the same reason, the data for 2023 is identical to that for 2022 and will be corrected in the next reporting.
- Some minor adjustments (roundings) to inorganic nitrogen fertiliser use data (total sales and division between fertiliser types) were done for the years 2015, 2017, 2020 and 2021, affecting the emissions of NH_3 and NOx.

2026
- The use of mineral N fertilisers for 2023 was corrected because statistical data was not available during the previous reporting. For the same reason, the data for 2024 is identical to that for 2023 and will be corrected in the next reporting.

Source-specific planned improvements

The entire agricultural emission calculation system will be migrated from Excel to the R environment in 2026.

5.5.2 Livestock manure applied to soils (NFR 3Da2a)

Changes in chapter	
February 2026	JG, JM, TF

Source category description

Nitrogen oxides, NMVOC and ammonia emissions due to application of manure to soils are included under this category.

Emission trend

The emissions fluctuate according to the amount of manure applied annually (Figure 5.17).

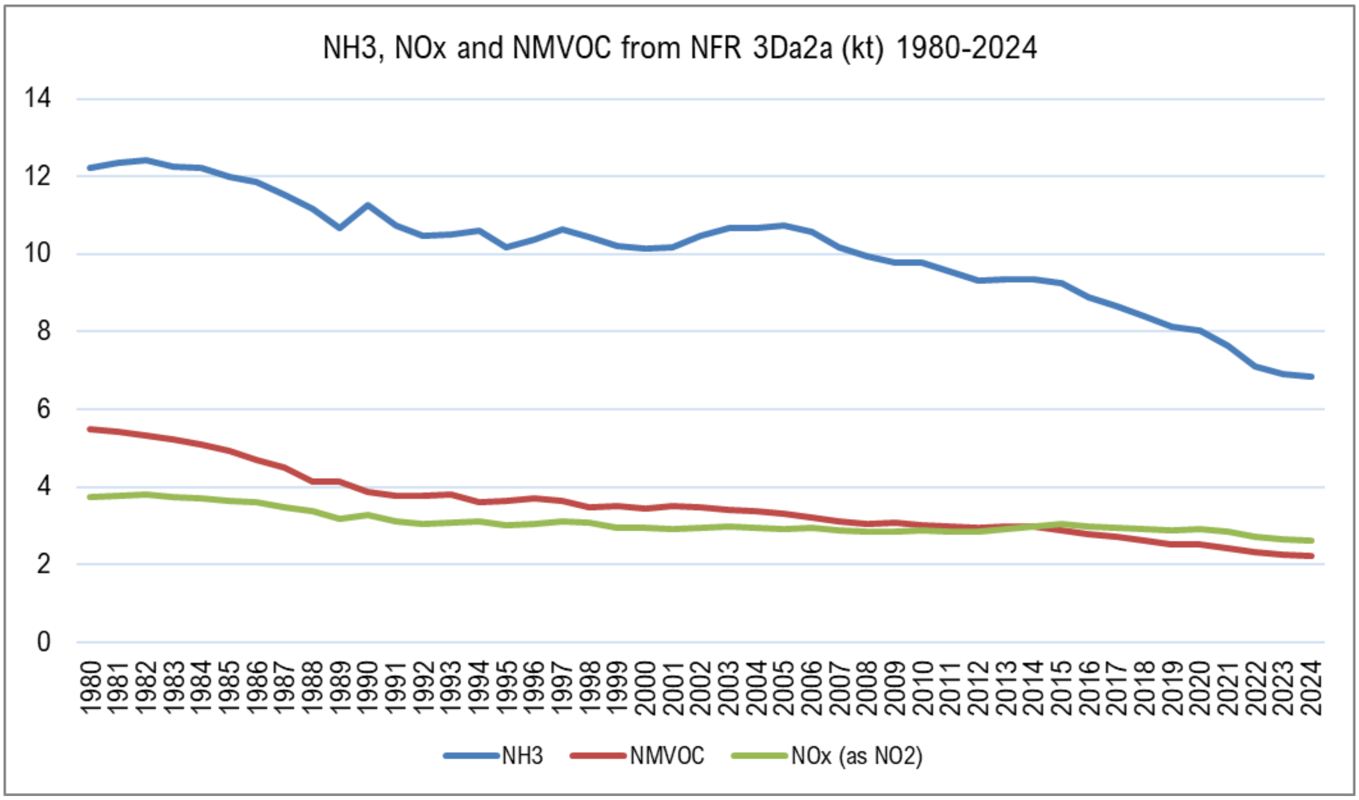


Figure 5.17 NOx, NMVOC and NH_3 *emissions 1980-2024 from manure application to soils.*

Methodological issues

Ammonia emissions

For the detailed description see Grönroos et al 2017 (in the CDR folder).

Nitrogen dioxide emissions

The calculation is carried out in the Agriculture Emissions Calculation Model (Grönroos et al., 2017). For nitrogen dioxide, the emission factor of 0.04 kg NO_2 kg^{-1} manure-N applied (EMEP/EEA 2023) was used.

NMVOC

Calculation of NMVOC emissions from field application of manure follows the same principle than emissions from manure storage reported under NFR 3 B. The method is based on EMEP/EEA Guidebook 2023.

$$E_{manure_{application}} = E_{NMVOC_{house}} * \left(\frac{E_{NH3_{application}}}{E_{NH3_{building}}}\right)_i$$

Where,

i = Animal category

$E_{NMVOC_{house}}$ = NMVOC emissions from housing

$E_{NH3_{application}}$ = Ammonia emissions from application

$E_{NH3_{building}}$ = Ammonia emissions from housing

Activity data

Amount of manure total nitrogen applied to the fields totalled to 63.5 kt in 2024 and was divided per animal category as presented in Table 5.30.

Table 5.30. Amount of manure total nitrogen applied to the fields in 2024.

Animal type	Tonnes of tot-N
Bulls >1 yr	5104
Calves <1 yr	8509
Dairy cows	24302
Heifers >1 yr	5506
Suckler cows	2375
Boars	12
Fattening pigs	4273
Sows	1410
Weaned pigs	594
Broiler hens	266
Broilers	1869
Pullets	137
Cockerels	17
Laying hen breeders	1242
Other poultry	6
Turkeys	210
Horses	1797
Ponies	191
Goats	29
Sheep	456
Foxes and raccoons	1247
Minks and fitches	405
Reindeer	0
TOTAL	59954

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2017

- Nitric oxide emissions expressed as nitrogen dioxide (NO_2) were included to the inventory for first time for the whole time series.

2018

- The emission factor for NOx emissions from NFR 3Da2a was updated to the 2018 submission. In the previous submission (2017), the emission factor of 0.04 was assumed to mean NO emissions, and the result was further multiplied by 46/30 to convert NO emissions to NO_2 emissions, resulting too high emission values for NO_2.

2024

- Changes in excretion rates and updates in the manure management calculation (see chapter 5.4) also affect the emissions of nitrogen compounds and NMVOC from livestock manure application.

2025

- Changes in excretion rates and updates in the manure management calculation (see chapter 5.4) also affect the emissions of nitrogen compounds and NMVOC from livestock manure application.
- Volatilisation coefficients of pig slurry application on plant covered land were corrected. They were not updated during the previous update event. This change impacts emissions of all nitrogen compounds and NMVOC.
- For volatilisation coefficients of boar slurry and urine application, the same coefficients are now used than is used for fattening pigs. Previously, the same factors as are used for sows were applied. This change impacts slightly emissions of all nitrogen compounds and NMVOC.
- IPCC 2006 N_2O-emission factors were replaced with IPCC 2019 emission factors (manure management, nitrogen additions to soil). These changes impact slightly emissions of all nitrogen compounds and NMVOC.
- N_2O emission calculation for manure application, grazing and dry lots was corrected: NH_3-N and NOx-N emissions are subtracted from the manure nitrogen before calculation of N_2O-N emissions. These changes impact only N_2O emissions.
- Number of sows 2009 was adjusted: 155902 -> 155900. Numbers of horses and ponies 2023 were adjusted. Numbers of fur animals for 1998 and 2010 were adjusted. These changes impact all emission compounds.

2026

- The numbers of bulls and pigs in 2022, and pigs, laying hens and cockerels in 2023 were adjusted. These changes impact all emission compounds.
- Calculation of NOx and N_2O emissions from deep litter application was corrected to consider also the manure that is not stored before application. This change impacts emissions of NOx and N_2O.

Source-specific planned improvements
The entire agricultural emission calculation system will be migrated from Excel to the R environment in 2026.

5.5.3 Sewage sludge applied to soils (NFR 3Da2b)

Changes in chapter	
February 2026	JG, JM, TF

Source category description

The category includes nitrogen oxides and ammonia emissions from the application of sewage sludge.

Emission trend

The emission trend is impacted by the amount of sludge which started to decrease since 1998 due to Finland's joining the EU earlier in 1995. As late as in the beginning of the 1990's sludge storages were too small and sludge spreading was common even in the wintertime. After Finland joined the EU, the amounts of sludge spread decreased significantly. (Figure 5.18). Since 2005, the applied amounts have increased steadily, levelling off again in the last few years.

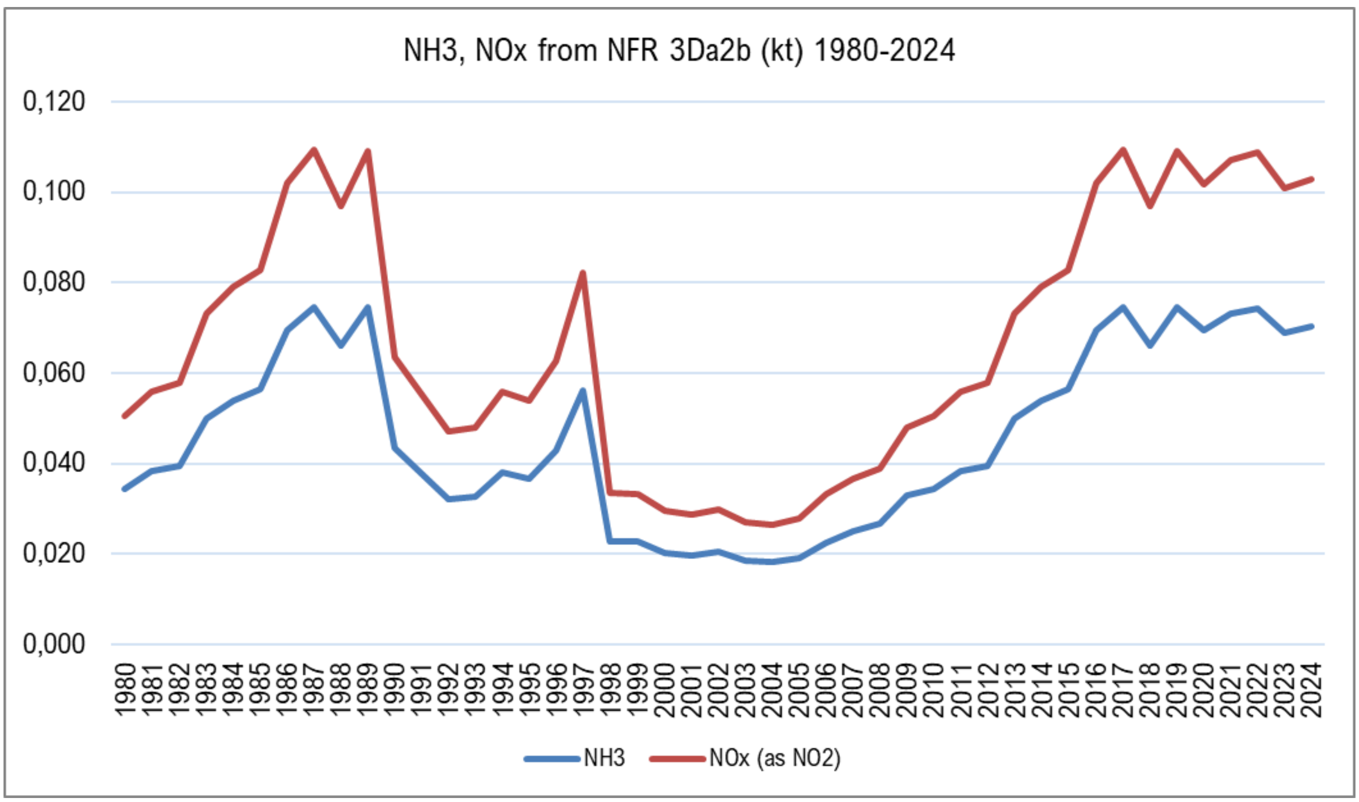


Figure 5.18. Sewage sludge applied to soils 1980-2024.

Methodological issues

Ammonia

N input from sewage sludge used in agriculture (Finland's NID 2026) is used as activity data (Table 5.31). It is assumed that 15 % of total nitrogen is in the form of ammonium nitrogen and that 15 % of the ammonium nitrogen evaporates during the spreading on the fields.

NO_x emissions

N input from sewage sludge used in agriculture (Finland's NID 2026) is used as activity data (Table 5.31). It is assumed that 4 % of total nitrogen is lost as NO_2 when applied to soils.

Table 5.31 N input from sewage sludge 1990-2024 (Mg N/year).

Year	N input (Mg N/year)	Year	N input (Mg N/year)	Year	N input (Mg N/year)	Year	N input (Mg N/year)
1990	1 586	2000	741	2010	1 260	2020	2 545
1991	1 384	2001	718	2011	1 400	2021	2 674
1992	1 181	2002	748	2012	1 444	2022	2 722
1993	1 199	2003	679	2013	1 826	2023	2 520
1994	1 396	2004	664	2014	1 978	2024	2 570
1995	1 345	2005	695	2015	2 066		
1996	1 566	2006	828	2016	2 547		
1997	2 058	2007	917	2017	2 731		
1998	837	2008	976	2018	2 420		
1999	831	2009	1 203	2019	2 729		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2013

- Ammonia emissions from sewage sludge application were included in the inventory 2018.
- NOx emissions were included in the inventory due to the recommendation of the NECD 2017 review.

2020

- N input from sewage sludge for whole timeseries was updated.

2024

- N input from sewage sludge for the year 2021 was updated based on the Finland's National Inventory Document (NID) under the UNFCCC and Paris Agreement 2024, affecting the NH_3 and NOx emissions.

2026

- N input from sewage sludge for the year 2023 was updated based on the Finland’s NID 2026, affecting the NH_3 and NOx emissions.

Source-specific planned improvements

The entire agricultural emission calculation system is intended to be migrated from Excel to the R environment. The timetable for other than manure related emission calculation is still open.

5.5.4. Other organic fertilizers applied to soils (NFR 3Da2c)

Changes in chapter	
February 2026	JG

Source category description

The category includes nitrogen oxides and ammonia emissions from the application of anaerobically treated, composted or untreated organic materials used as fertilisers.

Emission trend

The emission trend is impacted by the mass and nitrogen content of the other organic wastes applied to soils. (Figure 5.19).

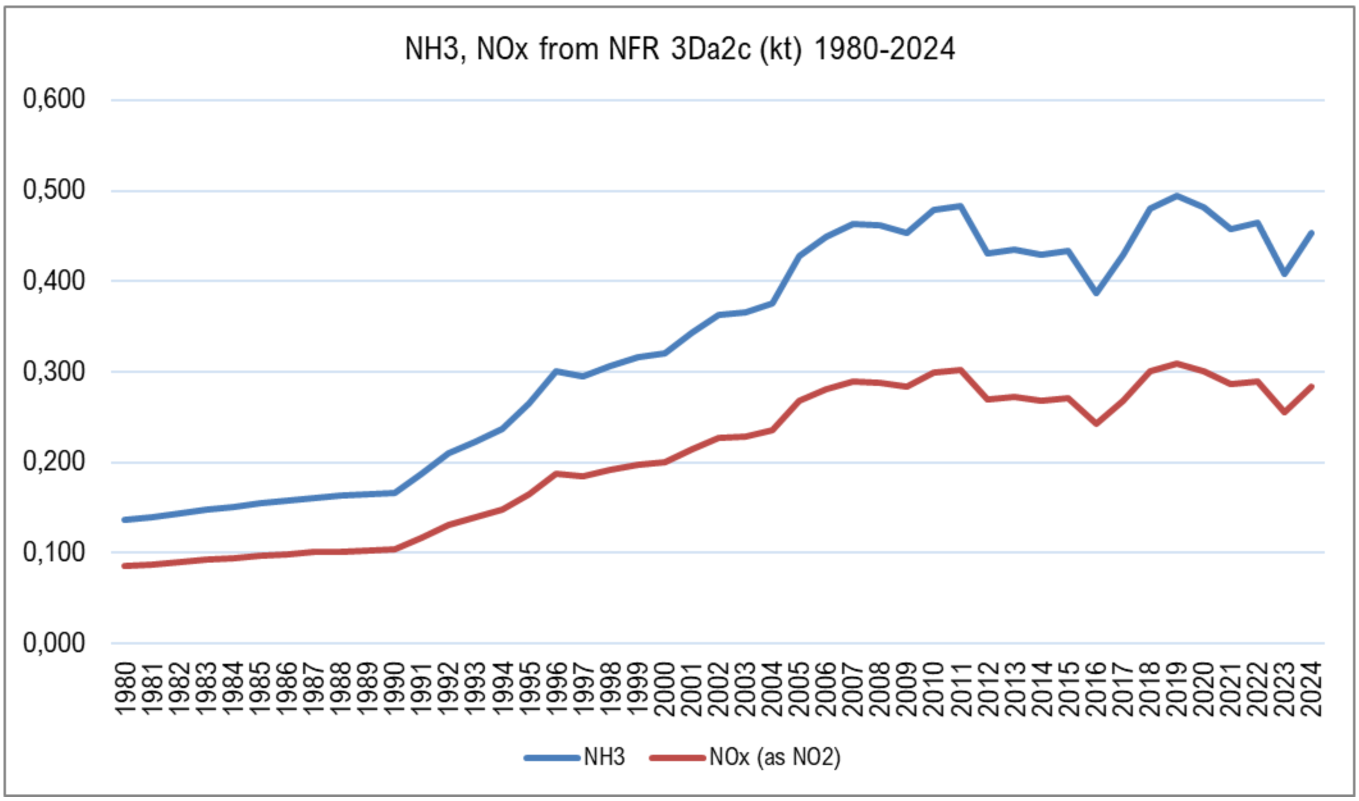


Figure 5.19. Other organic fertilisers applied to soils 1980-2024.

Methodological issues

Ammonia emissions

Ammonia emissions are calculated using EMEP/EEA Guidebook 2023 emissions factor of 0.08 kg NH_3 per kg total-N applied.

A temperature factor has been used in the ammonia emission calculations for manure management and application to account for the effect of Finland's cold climate compared to the climate of Central Europe, where emission measurements are typically conducted. However, the impact of temperature on emissions had not previously been considered in the calculation of emissions from the application of other organic fertilizers to fields, but it was included first time in the reporting for 2025. The temperature factor of 0.8 is applied, corresponding to a six-degree Celsius difference in average temperature between Finland and Central Europe.

N input from untreated (potato cell sap and meat and bone meal) organic wastes used in agriculture is used as activity data and is obtained from Finland's NID 2026. For composted and anaerobically treated wastes, the waste masses are used as activity data (Finland's NID 2026). The nitrogen contents of the composted and anaerobically treated wastes were obtained by using the best available waste-specific data on waste properties (Anon. 2020).

NO_x emissions

NO_x emissions are calculated using EMEP/EEA Guidebook 2023 emissions factor of 0.04 kg NH_3 per kg total-N applied. Activity data is the same as is used in ammonia emission calculation.

Due to a lack of information, it is not known exactly which part of the waste is used in agriculture as a fertilizer and which part is used, for example, in landscaping. It is supposed that 100% of anaerobically treated and untreated materials and 50% of composted materials are applied on agricultural soils.

Annual nitrogen input from other organic fertilisers applied to soils is presented in Table 5.32.

Table 5.32 N input from other organic waste applied to soils 1990-2024. (Mg N/year)

Year	N input (Mg N/year)	Year	N input (Mg N/year)	Year	N input (Mg N/year)	Year	N input (Mg N/year)
1990	2 606	2000	5 007	2010	7 477	2020	7 527
1991	2 934	2001	5 365	2011	7 559	2021	7 158
1992	3 273	2002	5 678	2012	6 724	2022	7 251
1993	3 491	2003	5 707	2013	6 807	2023	6 382
1994	3 709	2004	5 877	2014	6 706	2024	7 089
1995	4 138	2005	6 697	2015	6 767		
1996	4 690	2006	7 014	2016	6 050		
1997	4 607	2007	7 249	2017	6 699		
1998	4 785	2008	7 207	2018	7 512		
1999	4 946	2009	7 083	2019	7 725		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out.

Source-specific recalculations including changes made in response to the review process

2018

- The notation key was changed to NO.

2022

- Ammonia and NOx emissions from other organic fertilisers applied to soils were included in the inventory.

2024

- Masses of anaerobically digested other organic wastes and energy crops for the years 2014-2021 were updated based on the most recent data obtained from the Finland's NID 2024, and the NH_3 and NOx emissions were recalculated respectively.

2025

- Masses of other organic fertilisers for 2022 were updated because statistical data was not available during the previous reporting. For the same reason, some of the activity data for 2023 is identical to that for 2022 and will be corrected in the next reporting.
- As has long been the case with ammonia emission calculation for manure management and application, a temperature factor has now included in the calculation of ammonia emissions originating from other organic fertilisers applied to soils. The temperature factor of 0.8 is applied, corresponding to a six-degree Celsius difference in average temperature between Finland and Central Europe (see Grönroos et al. 2017).

2026

- Masses of anaerobically digested and composted wastes for the entire time series were updated (minor changes and reduced rounding) based on the most recent data from Finland's NID 2026, and the NH_3 and NOx emissions were recalculated respectively.

Source-specific planned improvements

The entire agricultural emission calculation system is intended to be migrated from Excel to the R environment. The timetable for other than manure related emission calculation is still open.

5.5.5 Urine and dung deposited by grazing livestock (NFR 3Da3)

Changes in chapter	
February 2026	JG, JM, TF

Source category description

This source category includes emissions originating from urine and dung deposited by grazing livestock to fields during grazing.

Emission trend

The emission trends (Figure 5.20) are affected by changes in animal numbers, N-excretion rates, percentage of grazing livestock and length of the grazing period. Since the beginning of 1980's, numbers and grazing of other cattle than suckler cows have decreased, resulting decrease in total emissions. However, increase in numbers of horses, ponies and suckler cows as well as increased nitrogen excretion rates of especially cattle have smoothened the decreasing trend in emissions.

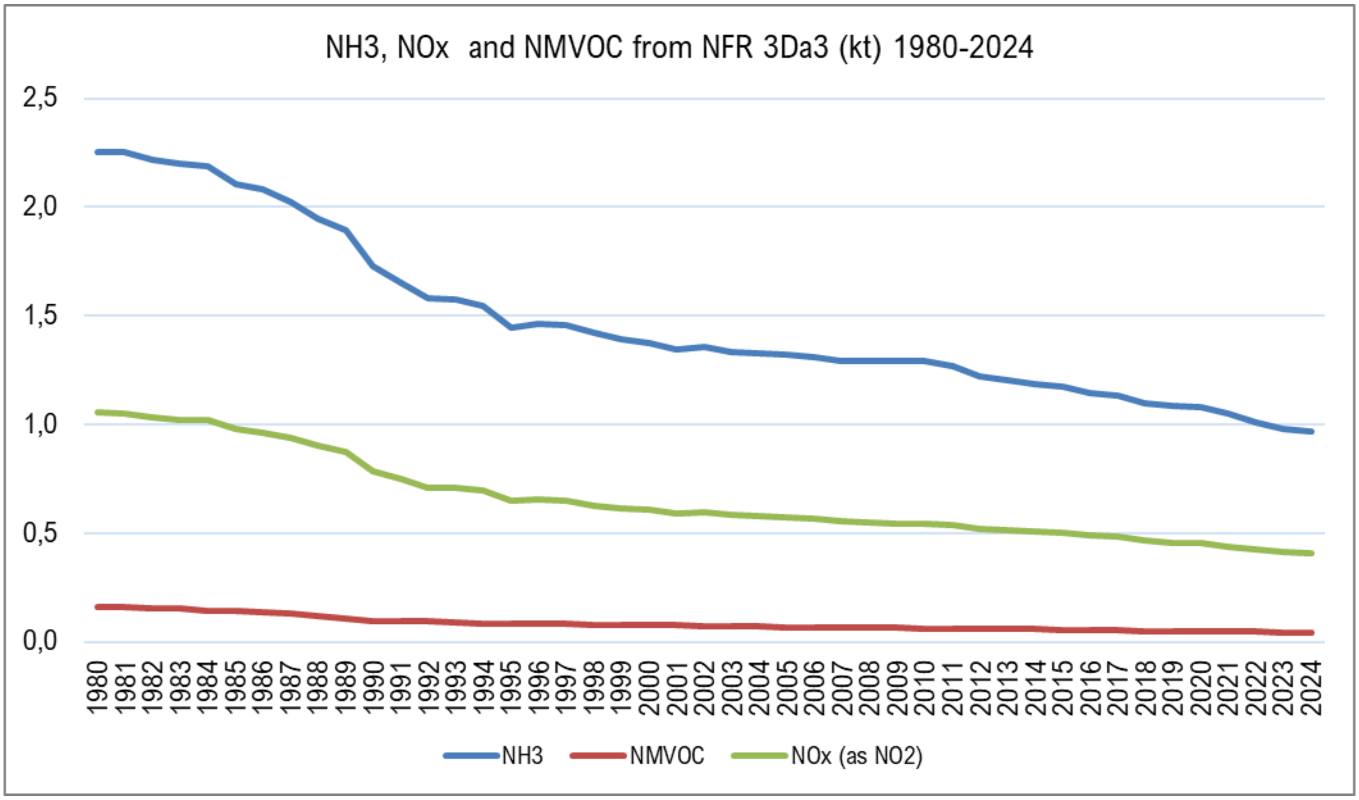


Figure 5.20 NO_x, NMVOC and NH_3 *emissions from 3Da3 in 1980-2024.*

Methodological issues

Ammonia emissions

For the detailed description, see Grönroos et al 2017 (in the CDR folder).

Nitrogen dioxide emissions

The calculation is carried out in the Agriculture Emissions Calculation Model (Grönroos et al., 2017). For nitrogen dioxide, the emission factor of 0.04 kg NO_2 kg^{-1} manure N excreted on pasture (EMEP/EEA 2023) has been used.

NMVOC

Emissions from outdoors grazing of livestock are calculated by gross feed intake (cattle) and volatile solids (other livestock) with an estimate of the time spent outdoors. The time animals spend indoors is estimated annually. The estimates are retrieved from the Finnish Normative Manure System. The emission factors in Table 5.33 are from EMEP/EEA Guidebook 2023.

Cattle:

$$\boldsymbol{E_{graz} = MJ_i * (1 - X_{house_i}) * EF_{graz_i}}$$

Other livestock:

$$E_{graz} = VS_i * (1 - X_{house_i}) * EF_{graz_i}$$

where,

i	= Animal category
MJ_i	= Gross feed intake as (MJ/a)
VS_i	= Volatile solids excreted (kg/a)
EF_{graz_i}	= Emission factor for grazing presented in Table 5.33.
X_{house_i}	= annual proportion of time the animal spends inside a livestock building (%; Table 5.20)

Table 5.33 NMVOC emission factors for grazing livestock (Source EMEP/EEA Guidebook 2023).

NFR	Livestock	$EF_{grazing}$	Unit
3B1a	Dairy cattle	6,90E-06	kg NMVOC kg/MJ feed intake
3B1b	Non-dairy cattle	6,90E-06	kg NMVOC kg/MJ feed intake
3B2	Sheep	2,35E-05	kg NMVOC/kg VS excreted
3B4a	Buffalo	2,35E-05	kg NMVOC/kg VS excreted
3B4d	Goats	2,35E-05	kg NMVOC/kg VS excreted
3B4e	Horses	2,35E-05	kg NMVOC/kg VS excreted
3B4f	Mules and Asses	2,35E-05	kg NMVOC/kg VS excreted
3B4h	Other animals (reindeer)	2,35E-05	kg NMVOC/kg VS excreted

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2017
- Nitric oxide emissions expressed as nitrogen dioxide (NO_2) were included to the inventory for first time in the 2017 submission for the whole time series (1990-2016).

2018
- NFR 3Da3: The emission factor for NOx was changed due to the change in the 2016 EMEP/EEA Guidebook. The emissions decreased by 40%.

2024
- Changes in excretion rates (see chapter 5.4) also affect the emissions of nitrogen compounds and NMVOC from urine and dung deposited by grazing animals.

2025
- Changes in excretion rates (see chapter 5.4) also affect the emissions of nitrogen compounds and NMVOC from urine and dung deposited by grazing animals.

2026
- The number of bulls in 2022 were adjusted. This change impacts all emission compounds.

Source-specific planned improvements

The entire agricultural emission calculation system will be migrated from Excel to the R environment in 2026.

5.5.6 Crop residues applied to soils (NFR 3Da4)

Changes in chapter	
January 2026	JG

Source category description

3.D.a.4 emissions from crop residues are calculated as outlined below and is based on the GB2023. This methodology applies to direct emissions from crop residues on the field.

Crop residues are defined as those parts of the crop left on the soil surface following harvest or after another management action such as cutting grass for silage or hay, or trimming pasture to stimulate fresh growth. Grass biomass killed using herbicides (due to renovation) or frost (in the Finnish conditions, every winter), potato haulms dessicated by acid application and green manures that die after frost are also to be included in the calculation.

Ammonia emissions from crop residues are related to the amount and nitrogen content of the residue left on the soil surface. Information on farm practices, harvested crop areas, and the amounts and nitrogen contents of the residues are needed to calculate emissions from crop residues at national scale. The work of de Ruijter and Huijsmans (2019) is used within this context.

Emission trends

Ammonia

The ammonia emission trends follow the trends in the activity data (Figure 5.21 and Table 5.34). The emissions peaked in the beginning of 1990’s due to the temporal increase in fallow acreage. It peaked again in 2015, remaining relatively high thereafter, driven by the increased adoption of cover crops supported by incentive measures.

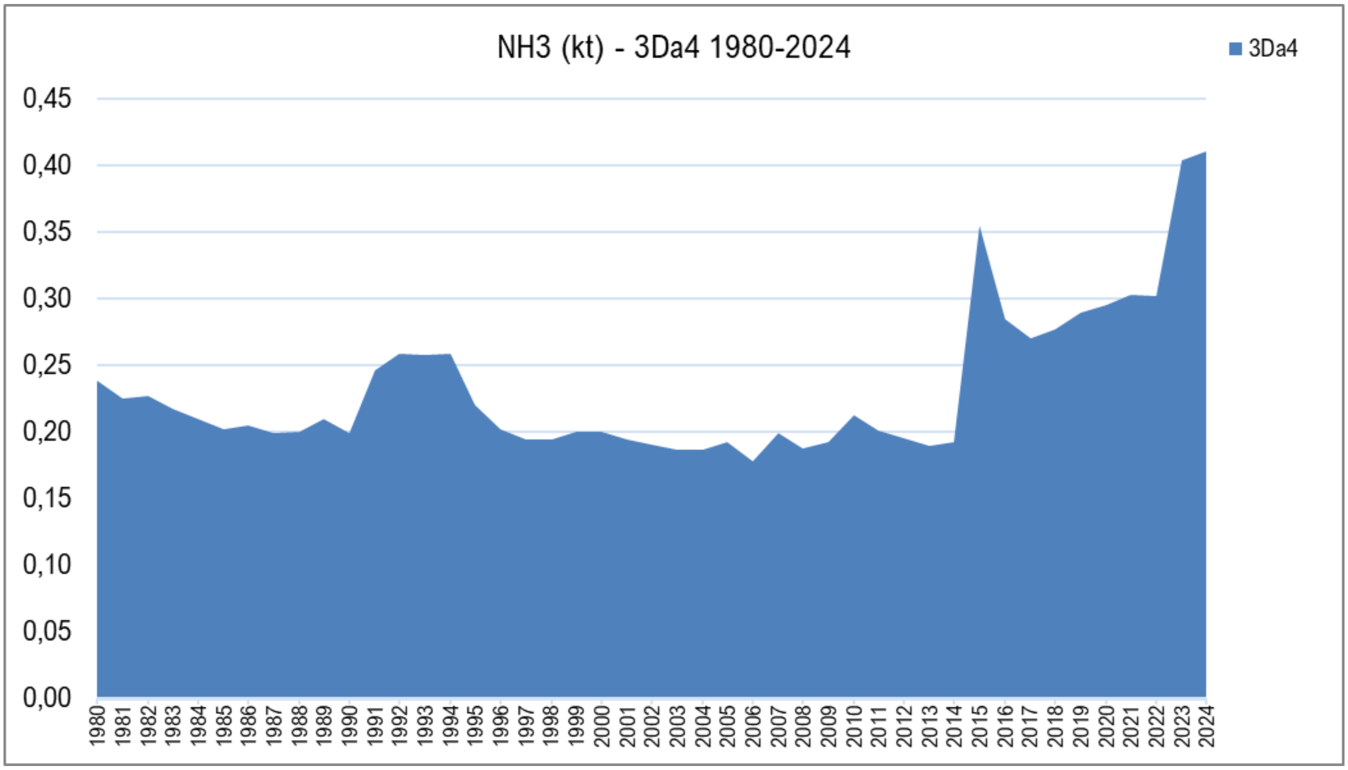


Figure 5.21. Ammonia emissions from crop residues (Gg) 1980-2024.

Table 5.34. Ammonia emissions from crop residues (Gg) 1980-2024.

Year	NFR 3Da4	Year	NFR 3Da4	Year	NFR 3Da4	Year	NFR 3Da4	Year	NFR 3Da4
1980	0.24	1990	0.20	2000	0.20	2010	0.21	2020	0.29
1981	0.23	1991	0.25	2001	0.19	2011	0.20	2021	0.30
1982	0.23	1992	0.26	2002	0.19	2012	0.20	2022	0.30
1983	0.22	1993	0.26	2003	0.19	2013	0.19	2023	0.40
1984	0.21	1994	0.26	2004	0.19	2014	0.19	2024	0.41
1985	0.20	1995	0.22	2005	0.19	2015	0.36		
1986	0.21	1996	0.20	2006	0.18	2016	0.29		
1987	0.20	1997	0.19	2007	0.20	2017	0.27		
1988	0.20	1998	0.19	2008	0.19	2018	0.28		
1989	0.21	1999	0.20	2009	0.19	2019	0.29		

Methodological issues

The calculation adheres mainly to the Tier 2 method outlined in the EMEP/EEA Guidebook 2023, focusing solely on ammonia emissions.

The NH_3 emission is calculated from the amount of total nitrogen in crop residues on the soil surface from which NH_3 may be emitted, an emission factor (EF) and a temperature factor (TempF). The equation makes allowance for the fraction of crop residues that are burned and will not therefore contribute to NH_3 emissions.

$$NH3_{cropres} = \frac{17}{14} * \sum A_T * N\_Load_T * F_T * EF\_cropres_T * TempF$$

where:

NH_3_cropres	= the NH_3 emission of the crop T (tonnes),
A_T	= the area of the crop T (1000 ha),
N_Load_T	= the above-ground production of crop residues nitrogen from the crop T (kg N ha^{-1} yr^{-1}),
F_T	= the fraction of the crop residues from the crop T that produce NH_3 emissions, i.e. the fraction that remains on the soil surface for longer than 3 days after harvesting,
$EF\_cropres_T$	= emission factor of the crop residues from the crop T (kg NH_3-N (kg N_load)$^{-1}$),
TempF	= temperature factor (0.8, see text).

The factor (17/14) converts NH_3-N to NH_3.

The nitrogen in crop residues to contribute to NH_3 emissions are those that remain on the soil surface for more than 3 days. Farming operations that remove crop residues from the soil surface include harvesting, incorporation and burning. The crop residue nitrogen also includes the nitrogen those created during forage or pasture renewal and green manures.

N_Load_T is calculated using the part of Equation 11.6 of IPCC (2019) that estimates above-ground residues:

$$N\_Load_T = AGR_T * NAG_T$$

Where:

AGR_T	= annual total amount of above-ground crop residue for crop *T*, kg DM ha^{-1} yr^{-1},
NAG_T	= nitrogen content of above-ground residues for crop *T*, kg N (kg DM) $^{-1}$. Default values from Table 11.1a of IPCC (2019) are shown in Table 5.35.

For calculating $\boldsymbol{AGR_T}$ the following equation is used (IPCC 2019):

$$AGR_T = Yield\_Fresh_T * DRY_T * R\_AG_T$$

where:

$Yield\_Fresh_T$	= harvested fresh yield for crop *T*, kg fresh weight ha^{-1},
DRY_T	= dry matter fraction of harvested crop *T*, kg DM (kg fresh weight)$^{-1}$,
R_AG_T	= the ratio of above-ground residue dry matter to harvested yield.

In the Finnish emission inventory, this equation is not used for certain crops. For those crops, the following methods have been used:

Potato	IPCC's equation in Table 11.2 of IPCC (2019).
Sugar beet	IPCC's equation in Table 11.2 of IPCC (2019). Slope and intercept as for potato.
Hay (harvesting losses)	A loss of 5% of total above ground dry matter was estimated for cut grassland (Suokangas 14.2.2024).
Hay/renovation	Sairanen (13.2.24): 1000 kg DM/ha for the year of establishment of the forage grass, and 2000 kg DM/ha for other three years. Thus, the annual average AGR is: ((3*2000)+1000)/4 = 1750 kg DM/ha. In the Finnish conditions, forage grasses die every autumn due to the cold climate. In the autumn of the third year, grass is terminated.
Silage (harvesting losses)	Same as Hay.
Silage/renovation	Same as Hay/renovation.
Pasture	In Ruijter and Huijsmans (2019), the amount of grass residues left behind after pasture topping was estimated to range between 200 and 500 kg dry matter per hectare, with a value of 350 kg used in the calculations. This value is also applied in the Finnish emission inventory.
Pasture/renovation	Same as Hay/renovation.
Other grassland (harvesting losses)	Same as Hay.
Other grassland/renovation	Same as Hay/renovation.

For forage grasses (hay, silage, pasture, other), crop residues and the emissions from them are calculated separately for harvesting losses and for renovation.

The calculation parameters used in the Finnish emission inventory are presented in Table 5.35.

The value of F_T is calculated by the following equation, adapted from IPCC (2019) and GB2023:

$$F_T = FracCuttedOrDead_T * (1 – (FracIncorp_T + FracRemove_T + (FracBurn_T * Cf)))$$

Where:

$FracCuttedOrDead_T$	= fraction of above ground biomass of crop T that is cutted/harvested or terminated by frost or use of pesticides,
$FracIncorp_T$	= fraction of residues from crop T incorporated within 3 days of harvesting (or in the case of grassland renovation, of termination (by frost or use of pesticides)), dimensionless,
FracRemoveT	= fraction of residues from crop T removed within 3 days of harvesting, dimensionless,

$FracBurnt_T$	= fraction of annual harvested area of crop T burnt within 3 days of harvesting, dimensionless (not needed because cereals and oil crops are omitted (+ burning is forbitten)),
Cf =	combustion factor (dimensionless) (refer to IPCC (2019) Chapter 2, Table 2.6) (not needed because cereals and oil crops are omitted (+ burning is forbitten)).

Table 5.35. Parameters (consistent across all inventory years) used to calculate NH_3 emissions from crop residues. R_{AG} = the ratio of above-ground residue dry matter to harvested yield (Finland's NID 2025), N_{AG} = nitrogen content of above-ground residues, F_{CD} = Fraction Cutted or Dead, F_I = Fraction Incorporated, F_R = Fraction Removed, F_B = Fraction Burned, CF = combustion factor, F_T = the fraction of the T th crop that remains on the soil surface for longer than 3 days after harvesting. Emissions are calculated for the crops on the grey-shaded rows (see text on emission factors).

Species	Yield DM (%)	R_{AG}	N_{AG} (kg N (kg DM)$^{-1}$)	F_{CD}	F_I	F_R	F_B	CF	F_T (fraction)
Wheat	0.86	1.84	0.006	1.00	0	0	0	0.9	1.00
Rye	0.86	1.99	0.006	1.00	0	0	0	0.9	1.00
Barley	0.86	1.25	0.007	1.00	0	0	0	0.9	1.00
Oats	0.86	1.59	0.007	1.00	0	0	0	0.9	1.00
Mixed grain	0.86	1.59	0.007	1.00	0	0	0	0.9	1.00
Other grains	0.86	1.59	0.007	1.00	0	0	0	0.9	1.00
Peas	0.86	1.43	0.008	1.00	0	0	0	0.9	1.00
Potatoes	0.22	1.00	0.019	1.00	0.02	0	0	0.9	0.98
Sugar beet	0.21	0.63	0.016	1.00	0.5	0	0	0.9	0.50
Turnip rape and rape	0.92	2.47	0.006	1.00	0	0	0	0.9	1.00
Hay	0.86	0.43	0.015	1.00	0	0	0	0.9	1.00
Hay/renovation			0.015	1.00	0.05	0	0	0.9	0.95
Silage	0.34	0.43	0.015	1.00	0	0	0	0.9	1.00
Silage/renovation			0.015	1.00	0.05	0	0	0.9	0.95
Pasture	0.20	0.43	0.015	0.20	0	0	0	0.9	0.20
Pasture/renovation			0.015	1.00	0.05	0	0	0.9	0.95
Other grassland	0.20	0.43	0.015	1.00	0	0	0	0.9	1.00
Other grassland/renovation			0.015	1.00	0.05	0	0	0.9	0.95
Other crops	0.86	1.60	0.007	1.00	0	0	0	0.9	1.00
Fallow	0.21	1.00	0.015	1.00	0	0.1	0	0.9	0.90
Cover crops	0.20	1.00	0.025	0.90	0.25	0	0	0.9	0.68

The $EF\_cropres_T$ is derived from the model of de Ruijter and Huijsmans (2019) and depends on the nitrogen concentration in crop residues (NAG_T; kg N (kg DM)$^{-1}$):

If the $NAG_T \leq 0.0132$ kg N (kg DM)$^{-1}$
$EF\_cropres_T = 0$

Otherwise
$EF\_cropres_T = (410 * NAG_T - 5.42)/100$

The temperature factor (TempF) is not included in the original Tier 2 method presented in the Guidebook. It is included to consider the effect of cold climate to ammonia emissions. In the Finnish emission inventory, the TempF has been used when ammonia emissions originating from animal manure are calculated (Grönroos et al. 2009, Grönroos et al. 2017). The ammonia emission factors (or volatilisation coefficients) are usually presented as proportion of TAN or tot-N volatilised, or as dimensionless factors (kg NH_3-N per kg N), which usually are based on studies representing climatic conditions different from those in Finland. The most important distinction can be found in outdoor temperature. Cowell and ApSimon (1996) assumed that a rise of 3˚C in temperature increases volatilisation of ammonia by 10%, based on Oldenburg (1989). The difference of 6˚C in the annual average outdoor temperature between Finland and Central Europe (Table 5.36) would thus mean a reduction of 20% in ammonia volatilisation, giving a correction factor of 0.8 for Finland.

Table 5.36. Average annual outdoor temperature (°C) in Finland (Jokioinen, Jyväskylä, Oulu and mean) and in Central Europe (Hannover (GE), De Bilt (NL), Nottingham (UK) and mean) in 1991-2020 (European Climate Assessment & Dataset: https://www.ecad.eu).

Region	Mean annual T (°C)
Jokioinen (FI)	5.2
Jyväskylä (FI)	3.8
Oulu (FI)	3.3
Hannover (DE)	10.1
De Bilt (NL)	10.6
Nottingham (UK)	10.1
Mean Finland	4.1
Mean Central Europe	10.3
Difference	6.2

Activity data

The calculation parameters used in the Finnish inventory are presented in table 5.35.
Area of cover crops are presented in Table 5.37.
Areas of other crops in 1980-2024 are presented in Table 5.38 in section 5.5.8.

Emissions are calculated only for crops with N_{AG} > 0.013 kg N (kg DM)$^{-1}$ (Ruijter and Huijsmans 2019; see Table 5.35). For potatoes, sugar beet, turnip rape and rape, hay, and silage the year specific yields per hectare come from statistics (Table 5.43 in chapter 5.5.10). For pasture and other grassland, the same yield is assumed than for silage. Field of fallow is assumed to be half of the yield of silage. For cover crops, the above- and belowground biomasses are assumed to be constant, i.e. 800 and 1200 kg DM ha^{-1}, respectively, based on the average yields of cover crops cultivated in Finland (Känkänen 2019). Mostly used cover crop species are graminoids (70%) but clovers are also used and therefore, the biomass is converted into nitrogen content using IPCC 2006 Guideline values for grass-clover mixture.

Table 5.37. Area (ha) of cover crops in 1980-2024 (Finland's NID 2026).

Year	Cover Crop Area (ha)
1980-2009	0
2010	5 786
2011	5 953
2012	6 108
2013	6 217

Year	Cover Crop Area (ha)
2014	6 434
2015	258 410
2016	140 045
2017	125 862
2018	122 775
2019	123 009
2020	138 414
2021	143 233
2022	144 929
2023	295 600
2024	298 901

Uncertainty and time series' consistency

The time series is consistent. The results of the uncertainty analysis are provided in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checks related to the assessment of magnitude and trends have been carried out. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes in response to the review

2026

- Area of cover crops for the years 2020-2023 was slightly adjusted. This change impacts NH_3 emissions.

Source-specific planned improvements

The refinement of activity data is an ongoing process.

The entire agricultural emission calculation system is intended to be migrated from Excel to the R environment. The timetable for other than manure related emission calculation is still open.

5.5.7 Indirect emissions from managed soils (NFR 3Db)

Changes in chapter	
January 2020	JG

Indirect emissions from managed soils are reported as NA, because no methodology is presented in EMEP/EEA Guidebook 2023.

5.5.8 Farm-level agricultural operations including storage, handling and transport of agricultural products (NFR 3Dc)

Changes in chapter	
February 2026	JG, JM, TF

Source category description

Particle emissions from cultivation, harvesting, cleaning, and drying of crops are included under this category.

Emission trend

The activity data figures fluctuate annually mostly due to market demands. The count of producers has been steadily declining since the 1990's and simultaneously the land area per producer has been increasing. Farming subsidy policies, which in the early 1990s were reshaped upon joining the European Union, is also a notable factor influencing the composition of Finnish agriculture in general. However, these factors do not present notable trends in emissions throughout the time series. A minor decline can be observed in total TSP emissions, despite the total land area for cultivated crops remaining constant (Figure 5.22) This is due to a slight shift from most common crops towards more specialized crops for which there is no emission factor for harvesting, cleaning or drying.

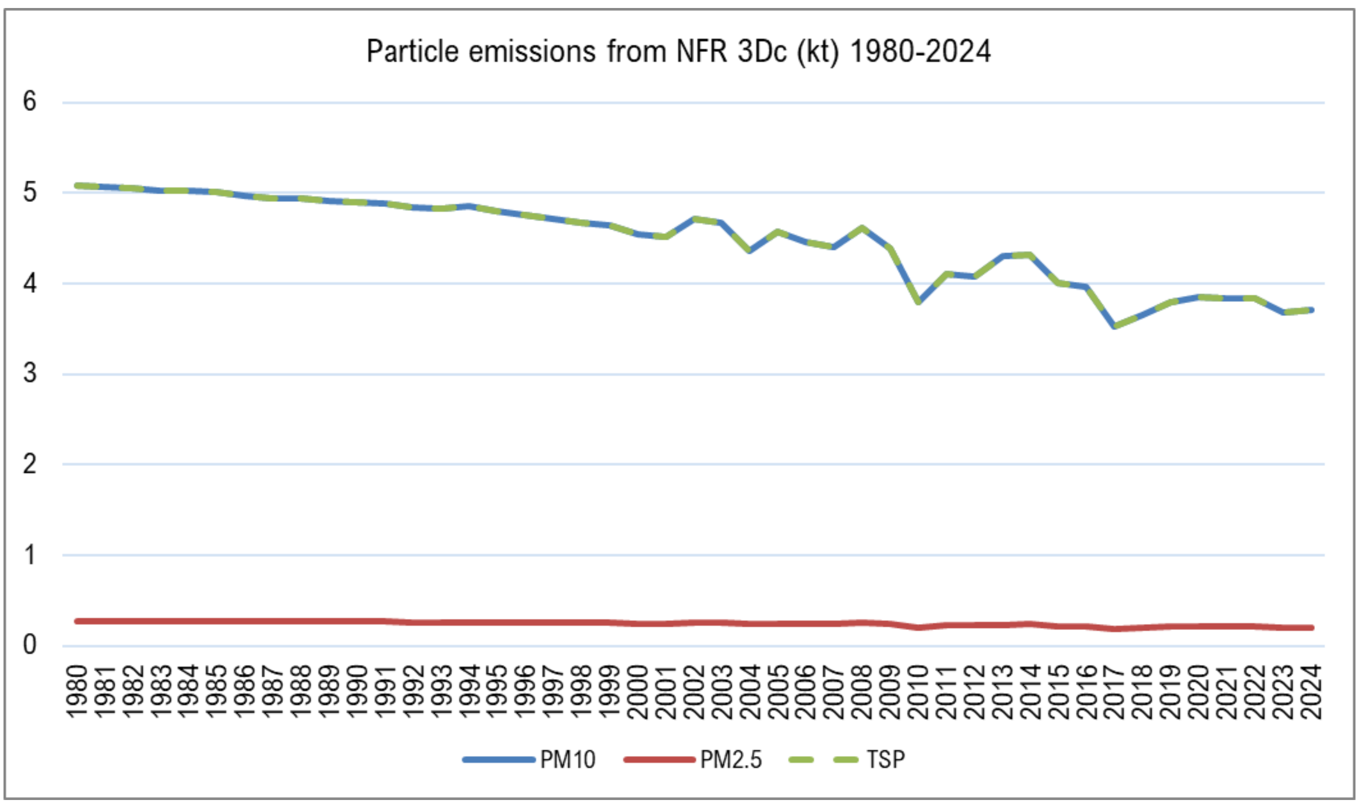


Figure 5.22 Particle emissions from NFR 3Dc 1990-2024.

Methodological issues

Activity data

Information on the use of arable land and harvested areas are provided by Natural Institute Resources Finland. For harvesting, data is available only from the year 2000 onwards. The figures used in calculation for 1990's are trend-projected values. Reliable statistics of cleaning and drying of crops does not exist and harvested areas are applied instead. This leads to a possible over-estimate on emission values for cleaning and drying, as it can be safely assumed that not all of the harvested crops go through these processes. The activity data used in calculation is presented in Tables 5.38a and b (Natural Resources Institute Finland, Luke).

Table 5.38a Use of arable land area as thousands of hectares 1990-2024 (Natural Resources Institute Finland, Luke)

Year	Wheat	Rye	Barley	Oats	Mixed grain	Other grains	Peas	Potatoes	Sugar beet	Turnip rape and rape	Hay	Silage	Pasture	Other grassland	Other crops	Fallow
1990	191	83	503	461	14	0	3	37	31	66	291	224	129	39	19	183
1991	118	10	541	343	12	0	11	36	32	61	232	234	120	37	21	494
1992	88	11	473	335	13	0	16	35	32	73	243	247	130	42	21	529
1993	99	23	459	332	13	0	13	36	33	69	255	261	125	46	20	494
1994	89	9	506	334	10	0	6	37	34	67	258	268	123	36	21	505
1995	101	21	516	329	11	1	5	36	35	85	287	301	127	40	25	223
1996	113	35	543	374	14	1	6	35	35	62	244	302	118	38	24	179
1997	125	23	583	369	16	2	6	33	35	61	220	314	114	39	25	162
1998	137	36	578	387	16	3	5	33	33	65	198	339	112	34	26	167
1999	118	12	581	404	18	1	5	32	35	63	175	350	114	33	25	211
2000	150	45	559	400	17	3	5	32	32	53	160	376	118	33	24	181
2001	145	29	547	423	16	1	5	30	31	73	158	381	94	32	25	202
2002	175	31	523	451	16	1	5	30	31	68	118	397	95	28	27	211
2003	192	31	531	426	16	1	4	29	29	75	101	399	102	27	30	220
2004	236	31	565	372	17	1	4	29	31	83	93	415	87	26	35	196
2005	215	14	595	346	16	1	4	29	31	77	107	398	92	24	45	241
2006	192	22	564	354	19	1	4	28	24	108	126	386	88	26	64	253
2007	204	32	550	362	20	1	4	28	16	90	103	438	90	23	64	232
2008	220	24	613	373	21	1	3	27	14	65	103	452	81	21	55	189
2009	218	16	601	343	23	2	4	26	15	81	86	450	79	25	57	230
2010	214	25	448	296	26	3	6	25	15	158	106	452	77	24	71	307
2011	257	27	465	324	28	3	5	25	14	92	103	472	75	17	67	276
2012	242	21	503	353	32	2	5	23	12	69	95	471	73	20	59	267
2013	231	12	533	367	33	2	4	22	12	53	93	466	72	19	50	254
2014	272	24	532	326	37	2	6	22	14	44	94	472	71	16	53	247
2015	249	32	513	307	36	3	12	22	13	57	86	492	58	16	75	271
2016	223	27	486	332	40	3	12	22	12	62	94	512	58	24	79	261
2017	219	32	437	337	43	3	11	22	12	65	87	552	57	21	90	254
2018	190	17	463	324	42	4	10	22	10	58	110	572	56	25	96	246
2019	206	38	455	319	41	6	14	22	11	37	118	593	54	22	88	222
2020	210	20	457	348	43	6	25	21	11	30	101	609	52	21	84	207
2021	217	18	448	332	41	6	23	20	11	38	119	610	51	22	74	213
2022	230	20	429	336	43	5	34	20	9	43	118	610	50	18	70	207
2023	245	27	406	323	43	8	44	19	12	39	111	611	49	15	72	225
2024	227	17	372	344	45	10	41	18	15	41	123	610	46	12	74	245

Table 5.38b Harvested area as thousands of hectares 1990-2024 (Natural Resources Institute Finland, Luke).

Year	Wheat	Rye	Barley	Oats	Mixed grain	Peas	Potatoes	Sugar beet	Turnip rape and rape	Hay	Silage
1990	*119*	*42*	*589*	*480*	*14*	*5*	*35*	*44*	*55*	*162*	*331*
1991	*124*	*40*	*588*	*474*	*14*	*4*	*35*	*44*	*56*	*160*	*333*
1992	*128*	*39*	*581*	*467*	*15*	*5*	*34*	*43*	*59*	*157*	*335*
1993	*133*	*39*	*578*	*461*	*15*	*4*	*34*	*42*	*61*	*155*	*339*
1994	*139*	*38*	*587*	*458*	*15*	*4*	*34*	*41*	*56*	*150*	*344*
1995	*142*	*36*	*590*	*450*	*15*	*4*	*33*	*39*	*59*	*146*	*348*
1996	*148*	*35*	*588*	*441*	*15*	*4*	*33*	*38*	*66*	*143*	*354*
1997	*154*	*35*	*581*	*428*	*15*	*4*	*33*	*36*	*71*	*139*	*361*
1998	*157*	*33*	*573*	*420*	*14*	*4*	*32*	*35*	*75*	*136*	*368*
1999	*163*	*31*	*569*	*414*	*16*	*4*	*31*	*33*	*77*	*133*	*373*
2000	149	45	559	400	17	5	32	32	53	158	372
2001	143	29	543	416	16	5	30	31	72	158	381
2002	174	30	522	451	16	5	30	31	66	118	397
2003	191	31	530	425	16	4	29	29	75	101	399
2004	225	27	532	326	16	3	27	30	68	91	412
2005	215	14	594	345	16	4	29	31	77	107	398
2006	192	22	564	353	19	4	28	24	107	125	384
2007	203	32	533	347	15	4	27	16	90	102	438
2008	216	24	586	355	13	3	26	14	64	102	451
2009	216	16	562	322	15	4	26	15	81	86	450
2010	211	25	417	278	19	6	25	15	158	106	452
2011	253	27	432	308	19	5	24	14	91	103	472
2012	227	21	451	314	21	4	21	12	57	95	471
2013	228	12	494	344	21	4	22	12	53	93	465
2014	267	24	497	305	24	6	22	14	43	94	472
2015	242	31	452	281	11	12	22	12	55	86	492
2016	215	26	436	305	14	10	22	12	60	94	511
2017	194	29	358	270	10	4	21	12	55	87	552
2018	178	16	405	289	15	9	21	10	53	110	570
2019	198	38	398	298	16	12	21	11	32	117	591
2020	199	19	392	325	8	21	21	11	25	101	609
2021	212	18	388	314	18	20	20	11	34	94	499
2022	220	19	369	321	20	31	19	9	41	87	474
2023	229	26	341	291	14	34	17	11	31	85	469
2024	215	16	322	328	16	37	18	14	37	96	479

** Figures in grey represents projected data.*

Particles

The emission factors are from EMEP/EEA Guidebook 2023. For TSP emissions same emission factor as for PM10 emissions is used. The emission factor of cultivation of “other arable” is applied to all cultivated species with available statistics. This leads to a minor increase in total particle emissions as opposed to the previous submissions. The wet climate emission factors of the EMEP/EEA Guidebook 2023 are applied to local crops as presented in Tables 5.39 a-c.

Table 5.39a TSP emission factor for farm-level agricultural operations: cultivation, harvesting, cleaning, and drying of crops (Applied to Finnish conditions from EMEP/EEA Guidebook 2023).

Species	TSP *			
	Cultivation	Harvesting	Cleaning	Drying
Wheat	0.250	2.7	0.190	0.560
Rye	0.250	2.0	0.160	0.370
Barley	0.250	2.3	0.160	0.430
Oats	0.250	3.4	0.250	0.660
Mixed grain	0.250	NC	NC	NC
Other grains	0.250	NC	NC	NC
Peas	0.250	NC	NC	NC
Potatoes	0.250	NC	NC	NC
Sugar beet	0.250	NC	NC	NC
Turnip rape and rape	0.250	NC	NC	NC
Hay	0.250	0.250	0.000	0.000
Silage	0.250	NC	NC	NC
Pasture	0.250	NC	NC	NC
Other grassland	0.250	NC	NC	NC
Other crops	0.250	NC	NC	NC
Fallow	0.250	NC	NC	NC
* PM10 EF's in use				

Table 5.39b PM_{10} emission factor for farm-level agricultural operations: cultivation, harvesting, cleaning, and drying of crops (Applied to Finnish conditions from EMEP/EEA Guidebook 2023).

Species	PM_{10}			
	Cultivation	Harvesting	Cleaning	Drying
Wheat	0.250	2.7	0.190	0.560
Rye	0.250	2.0	0.160	0.370
Barley	0.250	2.3	0.160	0.430
Oats	0.250	3.4	0.250	0.660
Mixed grain	0.250	NC	NC	NC
Other grains	0.250	NC	NC	NC
Peas	0.250	NC	NC	NC
Potatoes	0.250	NC	NC	NC
Sugar beet	0.250	NC	NC	NC
Turnip rape and rape	0.250	NC	NC	NC

Species	PM_{10}			
	Cultivation	Harvesting	Cleaning	Drying
Hay	0.250	0.250	0.000	0.000
Silage	0.250	NC	NC	NC
Pasture	0.250	NC	NC	NC
Other grassland	0.250	NC	NC	NC
Other crops	0.250	NC	NC	NC
Fallow	0.250	NC	NC	NC

Table 5.39c $PM_{2.5}$ emission factor for farm-level agricultural operations: cultivation, harvesting, cleaning, and drying of crops (Applied to Finnish conditions from EMEP/EEA Guidebook 2023).

Species	$PM_{2.5}$			
	Cultivation	Harvesting	Cleaning	Drying
Wheat	0.015	0.020	0.009	0.168
Rye	0.015	0.015	0.008	0.111
Barley	0.015	0.016	0.008	0.129
Oats	0.015	0.025	0.013	0.198
Mixed grain	0.015	NC	NC	NC
Other grains	0.015	NC	NC	NC
Peas	0.015	NC	NC	NC
Potatoes	0.015	NC	NC	NC
Sugar beet	0.015	NC	NC	NC
Turnip rape and rape	0.015	NC	NC	NC
Hay	0.015	0.010	0.000	0.000
Silage	0.015	NC	NC	NC
Pasture	0.015	NC	NC	NC
Other grassland	0.015	NC	NC	NC
Other crops	0.015	NC	NC	NC
Fallow	0.015	NC	NC	NC

$$\boldsymbol{E_i} = \sum \left(\left(\mathbf{EF}_{\mathbf{j,cultivation}} * \mathbf{A}_{\mathbf{j,cultivation}} \right) + \mathbf{A}_{\mathbf{j,harvesting}} \left(\mathbf{EF}_{\mathbf{j,harvesting}} + \mathbf{EF}_{\mathbf{j,cleaning}} + \mathbf{EF}_{\mathbf{j,drying}} \right) \right)$$

Where,

i	= Inventory year
j	= Crops species
EF	= Emission factor (cultivation, harvesting, cleaning or drying) as kg/ha
A	= Land area as hectares (cultivation or harvesting)

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2018

- Particle emission factors (as well as activity data) were revised from the TNO emission factors used earlier to those presented in the EMEP/EEA Guidebook 2016 due to the recommendation of the 2017 NECD review. The revision increased the emissions to be 10-fold compared to the earlier estimates.

2019

- Calculation of new species for which statistical data is available. Considered as “other arable” and the emissions were recalculated with Tier 2 methodology of EMEP/EEA Guidebook 2016.

2020

- Emission factors for harvesting updated according to the EMEP/EEA Guidebook 2019.

2026

- The areas of certain crop categories were adjusted for 2020–2023. In 2020, adjustments concerned other grains, other grassland and other crops; in 2021–2022, other crops; and in 2023, hay, silage, other grassland and other crops. These changes impact particle emissions.

Source-specific planned improvements

The entire agricultural emission calculation system is intended to be migrated from Excel to the R environment. The timetable for other than manure related emission calculation is still open.

5.5.9 Off farm storage, handling and transport of bulk agricultural products (NFR 3Dd)

Changes in chapter	
February 2021	JG

Emissions from off-farm storage, handling and transport of bulk agricultural products are reported as NA, because no methodology is presented in EMEP/EEA Guidebook 2023.

5.5.10 Cultivated crops (NFR 3De)

Changes in chapter	
February 2026	JG, TF

Source category description

This chapter describes the calculation of NMVOC from cultivated crops, grasslands and fallows that serve agricultural purposes. Activity data is provided by Natural Resources Institute Finland (Luke).

Emission trend

The activity data figures fluctuate annually mostly due to market demands and production rates of specific crops. NMVOC emissions follow this trend (Figure 5.23).

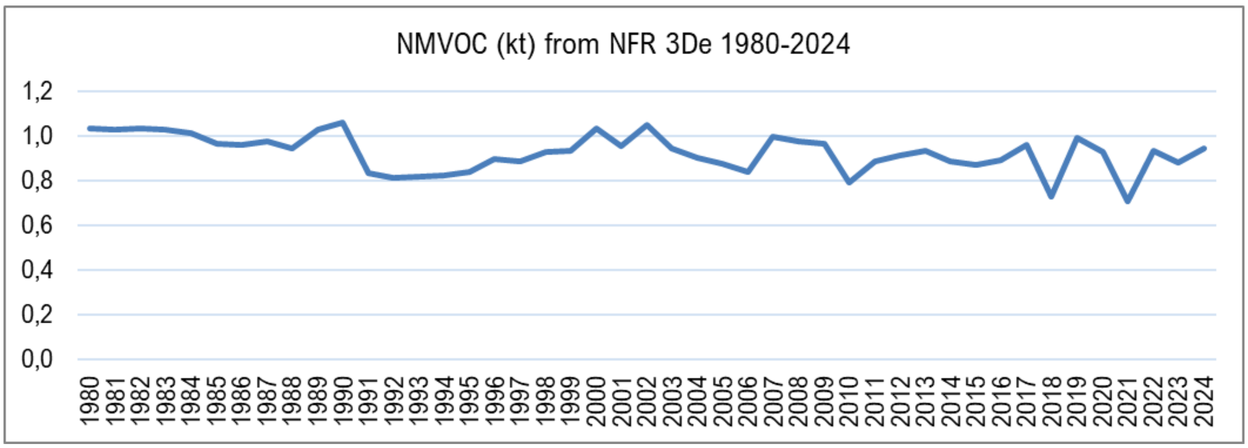


Figure 5.23 NMVOC emissions from cultivated crops 1990-2024.

Methodological issues

The emissions of cultivated crops are calculated according to the guidance of EMEP/EAA Guidebook 2023. The model is constructed to calculate by Tier 1 and Tier 2 methods with a possibility to extend calculation into Tier 3.

NMVOC

NMVOC emissions from cultivated crops such as cereals, grasslands and silage are included in the inventory. Table 5.40 presents total cultivated land area for the years 1990-2024. Table 5.41 presents cultivated land areas by species included in the inventory for the year 2024.

Table 5.40 Total cultivated land area 1990-2024 (thousands of hectares)

Year	Total Cultivated Area (kha)	Year	Total Cultivated Area (kha)	Year	Total Cultivated Area (kha)
1990	2 271	2005	2 235	2020	2 243
1991	2 302	2006	2 259	2021	2 243
1992	2 287	2007	2 255	2022	2 241
1993	2 278	2008	2 257	2023	2 232
1994	2 302	2009	2 257	2024	2230
1995	2 141	2010	2 253		
1996	2 122	2011	2 249		
1997	2 125	2012	2 248		
1998	2 166	2013	2 223		
1999	2 177	2014	2 230		
2000	2 187	2015	2 241		
2001	2 192	2016	2 243		
2002	2 204	2017	2 242		
2003	2 212	2018	2 243		
2004	2 219	2019	2 245		

Table 5.41 Total cultivated land area per species in 2024 (thousands of hectares)

Species	Cultivated area	SNAP
Wheat	227	100102
Rye	17	100102
Barley	372	100102
Oats	344	100102
Mixed grain	45	100102
Other grains	10	100102
Peas	41	100102
Potatoes	18	100102
Sugar beet	15	100102
Turnip rape and rape	41	100102
Hay	123	100105
Silage	610	100105
Pasture	46	100105
Other grassland	12	100105
Other crops	74	100104
Fallow	245	100101
Total	**2 230**	

The methodology for the calculation is based on EMEP/EEA Guidebook 2023 Tier 2 method, which reproduces the calculation of Tier 1 emission factor of by substituting the estimation of NMVOC Tier 1 emission factor in kg ha-1 a-1 with national data. The recalculation is done for each year independently, considering the annual relative changes within crop distribution and mean dry matter.

Default emission factor for Tier 1 calculation is 0.86 kg of NMVOC per hectare. The Tier 2 emission factor is calculated annually with the equation presented below.

$$\boldsymbol{EF_i = \sum \left(E_{j,NMVOC} * 24 * 365 * Frac_{emit,j} \right) * m_{dm_j} * Frac_{i,j}}$$

Where,

i	= Inventory year
j	= Crops species
$E_{j,NMVOC}$	= Hourly emission flux of NMVOC per species ($kg/dm^3/h$)
$Frac_{emit}$	= Fraction of the year during which the species is emitting
m_{dm}	= Mean dry matter of crop (kg/ha/a)
$Frac_{i,j}$	= Fraction of species j in relation to the total of cultivated areas and fallows for the year i

The EMEP/EEA Guidebook 2023 presents default values for calculation of the EF (Table 5.42). These defaults are used whenever national data is not available and replaced if more detailed information is available.

Mean dry matter is derived from national statistics of species-specific yields per hectare by estimating their share of dry matter. Yield mean dry matter content remains constant throughout all years. Statistical data for yield per hectare is available for 2000-2024. The values for the year 2024 are presented in Table 5.43.

The total cultivated area as thousands of hectares for all species accompanied with the calculated crop distribution (from the total of 2 230 000 hectares including fallows and other grasslands) of the year 2024 are presented in Table 5.44. Emission factors are presented in Table 5.45.

Table 5.42 Default values for emission factor calculation.

Species (i)	Ej,NMVOC	Fracemit	mdm,	Fracij
Wheat	2.60E-8	0,3	4 700	0.35
Rye	1.41E-7	0.3	2 800	0.05
Rape	2.02E-7	0.3	2 500	0.1
Grass (15 C)	1.03E-8	0.5	9 000	0.25
Grass (25 C)	4.67E-8	0.5	9 000	0.25

Table 5.43 Yields per hectare and dry matter of 2024 in Finland

Species	Yield per hectare (kg/ha)	Yield mean dry matter content (kg/kg)	Mean dry matter mdm (kg/ha)
Wheat	3 500	0.86	3 010
Rye	2 730	0.86	2 348
Barley	3 620	0.86	3 113
Oats	3 680	0.86	3 165
Mixed grain	2 980	0.86	2 563
Other grains	2 980	0.86	2 563

Species	Yield per hectare (kg/ha)	Yield mean dry matter content (kg/kg)	Mean dry matter mdm (kg/ha)
Peas	2 760	0.86	2 374
Potatoes	31 190	0.22	6 862
Sugar beet	47 600	0.23	10 948
Turnip rape and	1 330	0.92	1 224
Hay	3 340	0.86	2 872
Silage	17 550	0.25	4 388
Pasture	17 550	0.2	3 510
Other grassland	17 550	0.2	3 510
Other crops	9 000	0.22	1 980
Fallows	8 775	0.21	1 843

Table 5.44 Weighed emission factor and crop distribution of the year 2024, and NMVOC flux per for the main cultivated species.

Species	Cultivated area (1 000 ha)	Crop distribution (%)	NMVOC (kg/dm/a)	Weighted EF (kg NMVOC / ha / a)
Wheat	227	10.2 %	6.82E-05	2.09E-02
Rye	17	0.8 %	3.70E-04	6.66E-03
Barley	372	16.7 %	6.82E-05	3.55E-02
Oats	344	15.4 %	5.30E-04	2.58E-01
Mixed grain	45	2.0 %	6.82E-05	3.50E-03
Other grains	10	0.4 %	6.82E-05	7.84E-04
Peas	41	1.9 %	6.82E-05	3.00E-03
Potatoes	18	0.8 %	6.82E-05	3.82E-03
Sugar beet	15	0.7 %	6.82E-05	4.86E-03
Turnip rape and rape	41	1.9 %	5.30E-04	1.20E-02
Hay	123	5.5 %	4.51E-05	7.13E-03
Silage	610	27.4 %	4.51E-05	5.41E-02
Pasture	46	2.1 %	4.51E-05	3.29E-03
Other grassland	12	0.5 %	4.51E-05	8.41E-04
Other crops	74	3.3 %	4.51E-05	2.98E-03
Fallows	245	11.0 %	4.51E-05	9.14E-03

Table 5.45 Finnish NMVOC emission factors of cultivated crops in 5-year intervals and in 2024

Year	1980	1985	1990	1995	2000	2005	2010	2015	2020	2024
Total Cultivated Area	2 372	2 276	2 271	2 141	2 186	2 234	2 253	2 240	2 243	2 230
Emission Factor	0.482	0.470	0.513	0.431	0.477	0.399	0.358	0.396	0.419	0.427

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2018

- Open and stubble fallows were removed from the total cultivated area as these are not expected to be sources of NMVOC emissions.

Source-specific planned improvements

The entire agricultural emission calculation system will be migrated from Excel to the R environment. The timetable for other than manure related emission calculation is still open.

5.5.11 Use of pesticides (NFR 3Df)

Changes in chapter	
February 2026	JG, JM, TF, JM-P

Source category description

HCB emissions from the use of pesticides resulting from HCB residues in chlorine containing pesticides are included under this category.

Emission trend

The emission trend (Figure 5.24) was sharply declining in the early 2000s due to decreased use of Simazine, which was forbidden in 2004 in the EU. A new herbicide containing clopyralid was put on the market in Finland in 2010. The use of this new herbicide varies significantly between the years.

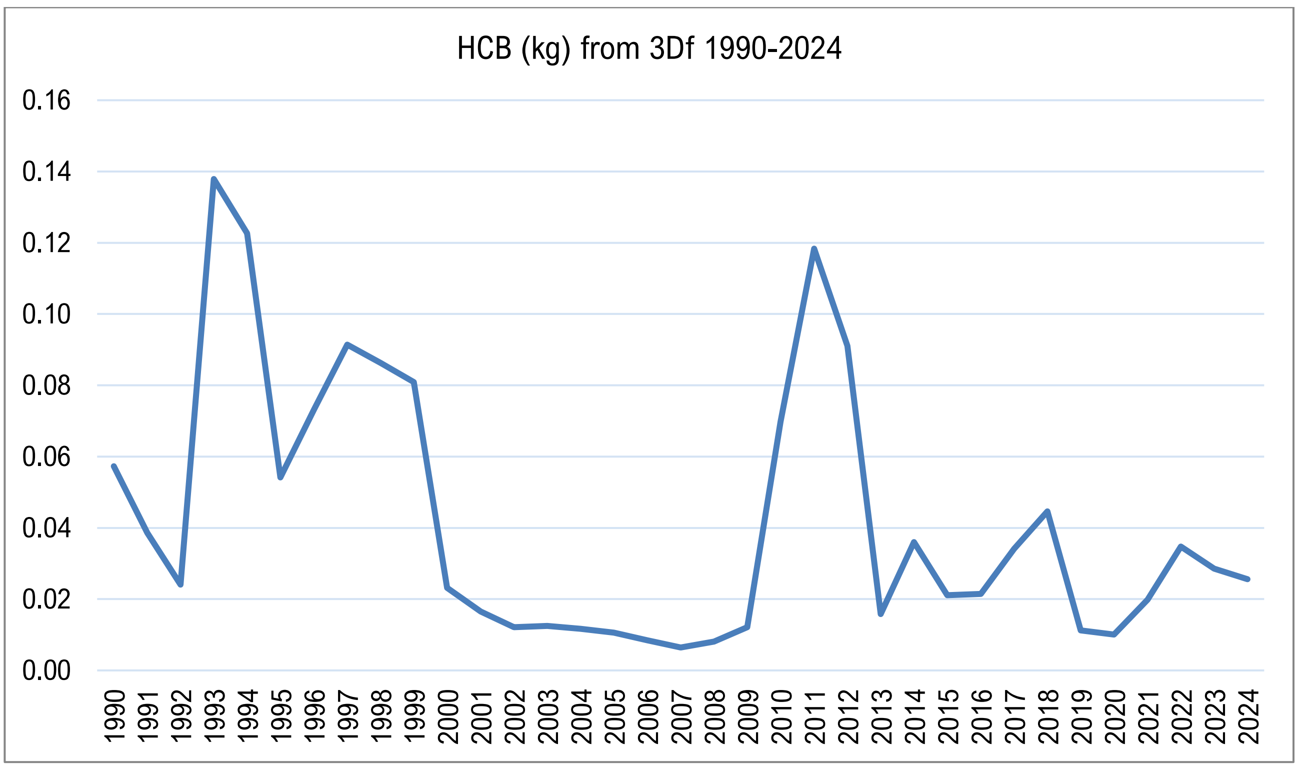


Figure 5.24 HCB from the use of pesticides 1990-2024.

Methodological issues

NH_3
In the EMEP/EEA Guidebook 2023, calculation of ammonia emissions from ammonia treated straw is presented. In Finland, straw is neither treated with ammonia nor urea, therefore NH_3 emissions from this category are reported as NA.

HCB emissions
The HCB impurity concentrations in certain pesticides have been used as emission factors as described in EMEP/EEA Guidebook 2023 in Table 3 and the sales of the effective substance (data from Finnish Safety and Chemicals Agency Tukes) in pesticides as activity data. Sales information provided by Tukes has been claimed confidential since the year 2009 and cannot therefore be published.

According to Finnish Safety and Chemicals Agency (Tukes) chlorothalonil has been sold in Finland by the trade name BRAVO 500 for years 1993-2001. The use of Bravo 500 has been approved for certain forestry purposes. Since 2009 chlorothalonil has been by the trade name Bravo Premium. The use of Bravo Premium has been approved for certain agricultural purposes.

During the manufacture of chlorine containing pesticides HCB may be formed as a by-product and part of this may be left in the product as an impurity (Jones, 2005). Pesticides where HCB can exist as impurity include Lindane, Dacthal (DCPA), Pentachlorophenol, Atrazine, Simazine. Picloram, Pentachloronitrobenzene (PCNB, quintozene), Chlorothalonil, Endosulfan and Clopyralid (Jones, 2005; Environment Canada, 2006, EMEP/EEA Guidebook 2023).

It is assumed that all HCB residues in the pesticides are emitted to the air, which might be considered as an overestimation.

Lindane, Dacthal, PCNB and Picloram have not been used or been included in pesticides used in Finland during the period 1990-2024. A new herbicide containing clopyralid was put on the market in Finland in 2010.

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2010 emissions. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2020

- The calculation of HCB emissions from chlorine containing pesticides was changed due to new information on the use of chlorothalonil and adoption of EMEP/EEA Guidebook 2019 emission factors.

2021

- As result from review during summer 2020 the impurity factor for chlorothalonil has been changed so the same impurity factor (10 mg/ kg) is used to calculate HCB emissions since year 2005.
- The activity data for 2018 was updated.

Source-specific planned improvements

None.

5.6 Field burning of agricultural residues (NFR 3F)

Changes in chapter	
February 2025	JG, JM, TF

Source category description

Field burning of crop residues is a source of NH_3, NO_x, CO, SO_x, NMVOC, particle (TSP, PM_{10}, $PM_{2.5}$, BC) and heavy metal emissions. PCDD/F and PAH emissions are also included in the inventory.

Burning of straw is forbidden in Finland from 1.1.2021.

Emission trend

The emission trends follow the trends in the activity data for all pollutants (Figure 5.25).

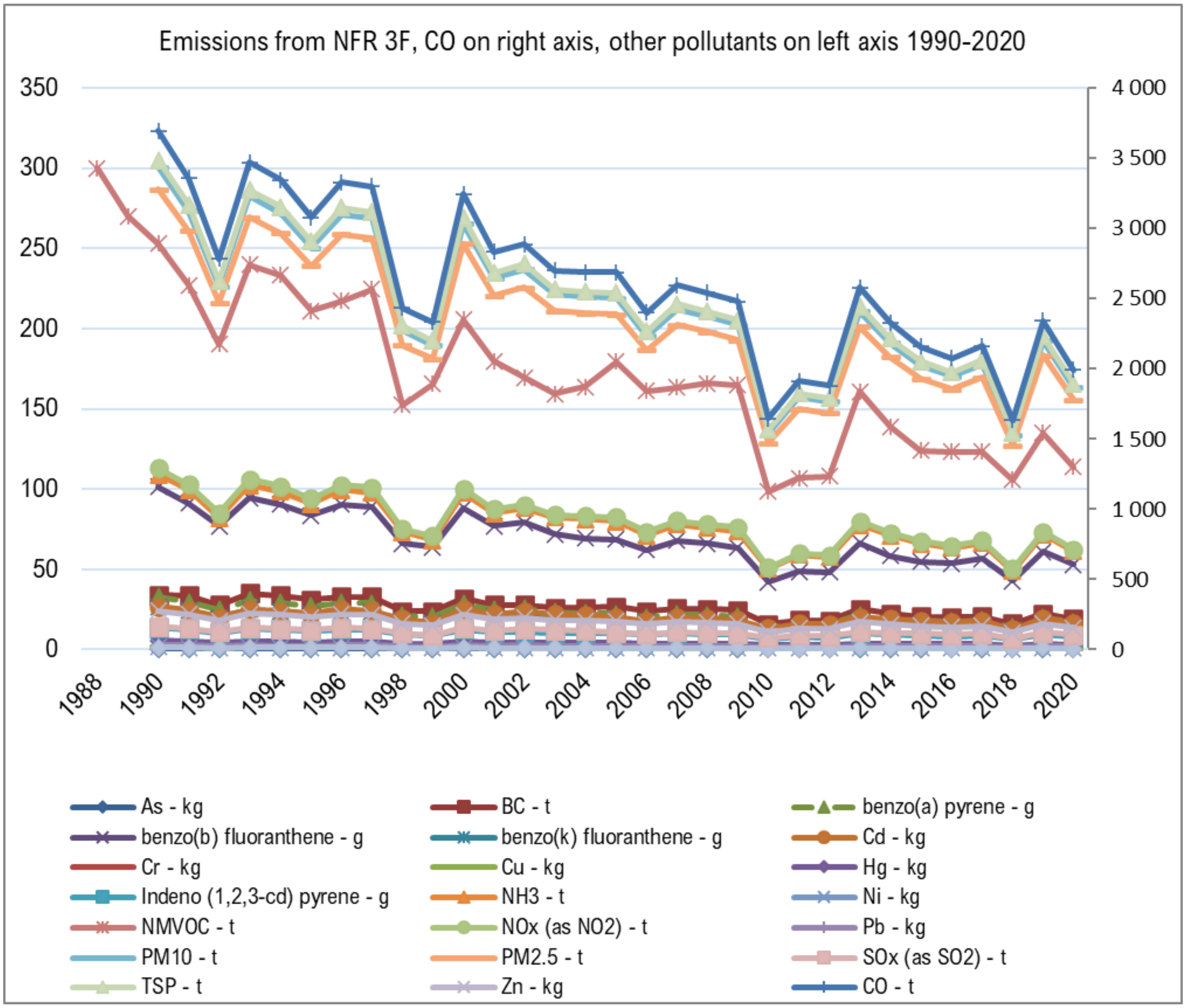


Figure 5.25 Emissions from field burning 1990-2020

Methodological issues

The calculation follows the methodology presented in EMEP/EEA Guidebook 2023.

Activity data

In Finland, field burning of agricultural residues has been prohibited since the beginning of 2021, based on the Government Decree 2015/4. Before that, burning of agricultural residues occurred only at small scale.

For the years 1980-2020, the annual crop yields for cereals and other crops are based on data from the Yearbook of Agricultural Statistics and the areas for cultivated cereals were also obtained from TIKE (the Information Centre of the Ministry of Agriculture and Forestry). The share of burned residue from total cereal residue on the fields for the years 1990-2013 was re-evaluated and simplified. The situation of residue burning for years 2013 (0.9%) and 2012 (0.7%) is rather accurately known as TIKE made an inquiry to the farmers. From the year 2014 onwards the estimate for burning is an average of years 2012 and 2013 (0.008)

The situation in the beginning of the 1990's is, however, still highly uncertain. Most likely, burning has been more common and an expert opinion (Ansalehto, 2007) supports this. Therefore, field burning in the year 1990 was estimated to be twice as much as the average of years 2012 and 2013 and was assumed to rise linearly from year 2012 backwards.

Estimates for the burned fraction of cereal residues are presented in Table 5.46a, and activity data for burned cereal residues are presented in Table 5.46b. Emission factors are from EMEP/EEA Guidebook 2023. Emission factors for wheat are used also for rye and oats (Table 5.47).

Table 5.46a Estimates of the burned fraction. Fraction of total residue burned is calculated by dividing the burned straw with total residue of all crops (as dry matter) (Finland's NID 2022 Table 5.5-2)

Year	Frac of residue burned, cereals	Frac of residue burned, total residue
1990	0.016	0.005
1995	0.014	0.005
2000	0.012	0.005
2005	0.010	0.004
2009	0.008	0.003
2010	0.008	0.003
2011	0.007	0.003
2012*	0.007*	0.003
2013*	0.009*	0.004
2014	0.008	0.003
2015	0.008	0.003
2016	0.008	0.003
2017	0.008	0.003
2018	0.008	0.003
2019	0.008	0.003
2020	0.008	0.003

*an estimate based on TIKE inquiry

Table 5.46b Activity data for total burned biomass (kt dm)

Year	Wheat	Barley	Oats	Rye	Total	Year	Wheat	Barley	Oats	Rye	Total
1990	5.97	20.57	17.82	1.16	45.52	**2010**	6.25	7.85	6.22	0.63	20.95
1991	6.26	18.42	15.79	1.04	41.51	**2011**	7.97	8.44	7.51	0.69	24.61
1992	3.90	15.47	14.01	0.91	34.29	**2012**	7.19	8.58	7.79	0.55	24.10
1993	5.93	19.51	16.29	0.97	42.69	**2013**	8.66	12.90	10.63	0.28	32.47
1994	6.05	19.02	15.02	0.91	41.00	**2014**	9.66	11.07	8.22	0.68	29.64
1995	5.77	17.14	14.08	0.94	37.93	**2015**	8.87	9.85	7.87	1.03	27.61
1996	6.79	17.55	15.73	1.39	41.45	**2016**	7.42	9.82	8.36	0.84	26.43
1997	6.72	18.24	15.04	0.73	40.73	**2017**	7.70	9.76	9.13	1.19	27.77
1998	5.69	12.26	11.80	0.86	30.60	**2018**	4.63	8.55	6.79	0.42	20.40
1999	3.43	13.49	11.26	0.34	28.53	**2019**	8.25	10.71	9.28	1.75	29.99
2000	7.10	16.54	15.57	1.52	40.73	**2020**	6.34	9.02	9.48	0.67	25.51
2001	6.22	14.48	13.93	0.87	35.50	**2021**	NO	NO	NO	NO	NO
2002	6.89	13.50	15.47	0.96	36.82	**2022**	NO	NO	NO	NO	NO
2003	7.93	12.70	12.82	0.92	34.37	**2023**	NO	NO	NO	NO	NO
2004	9.14	13.11	10.84	0.87	33.97	**2024**	NO	NO	NO	NO	NO
2005	8.62	14.52	9.81	0.38	33.33						
2006	7.05	13.06	9.03	0.57	29.71						
2007	7.91	13.14	10.64	0.94	32.62						
2008	7.52	13.39	10.17	0.63	31.71						
2009	8.03	13.34	9.02	0.41	30.79						

Emission factors

The emission factors used are from the EMEP/EEA Guidebook 2023 (Table 5.47). For wheat and barley Tier 2 EF is used. For oats and rye, the emission factor of wheat is used.

Table 5.47 Emission factors used for field burning of agricultural residues.

Pollutant	Wheat	Barley	Oats	Rye	Unit
NOx	0.0023	0.0027	0.0023	0.0023	kg kg-1 dm
CO	0.0667	0.0987	0.0667	0.0667	kg kg-1 dm
NMVOC	0.0005	0.0117	0.0005	0.0005	kg kg-1 dm
SOx	0.0005	0.0001	0.0005	0.0005	kg kg-1 dm
NH_3	0.0024	0.0024	0.0024	0.0024	kg kg-1 dm
TSP	0.0058	0.0078	0.0058	0.0058	kg kg-1 dm
PM10	0.0057	0.0077	0.0057	0.0057	kg kg-1 dm
PM2.5	0.0054	0.0074	0.0054	0.0054	kg kg-1 dm
BC	500	1200	500	500	mg kg-1 dm
Pb	0.11	0.0036	0.11	0.11	mg kg-1 dm
Cd	0.88	0.24	0.88	0.88	mg kg-1 dm
Hg	0.14	0.096	0.14	0.14	mg kg-1 dm

Pollutant	Wheat	Barley	Oats	Rye	Unit
As	0.0064	NA	0.0064	0.0064	mg kg-1 dm
Cr	0.08	0.14	0.08	0.08	mg kg-1 dm
Cu	0.073	0.0036	0.073	0.073	mg kg-1 dm
Ni	0.052	0.011	0.052	0.052	mg kg-1 dm
Se	0.02	0.039	0.02	0.02	mg kg-1 dm
Zn	0.56	0.49	0.56	0.56	mg kg-1 dm
Benzo(a)pyrene	67.7	98.8	67.7	67.7	mg kg-1 dm
Benzo(b)fluoranthene	189.1	307.4	189.1	189.1	mg kg-1 dm
Benzo(k)fluoranthene	80.7	77	80.7	80.7	mg kg-1 dm
Indeno(1.2.3-cd)pyrene	57.9	38.2	57.9	57.9	mg kg-1 dm

* For wheat and barley. Tier 2 EF is used. (EMEP/EEA Guidebook 2023)

* For PCDD/F Tier 1 EF is used for all species

Emission calculation equation for field burning of agricultural residues is:

$$\boldsymbol{E_i} = \sum (\mathbf{EF_{pollutant.}} * \mathbf{AR})_{\boldsymbol{j}}$$

Where.

i = Inventory year

j = Crops species

EF = Emission factor for pollutant (kg/kg dm)

AR = Activity rate (AR). mass of residue burnt (kg dry matter)

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2010 emissions. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2009

- Emissions from cereal straw (wheat. barley. oats. rye) burning were included.

2014

- The activity data for field burning was revised due to new information from inquiries in 2012 and 2013 for the whole time series and thus NH_3 emissions have also changed.

2015

- Calculation of emissions from field burning of agricultural residues was revised according to new emission factors presented in EMEP/EEA Guidebook 2013.

2016

- Calculation of emissions from field burning of agricultural residues was revised for the 2016 submission due to update of emission factors according to EMEP/EEA Guidebook 2016 and new studies that improved the activity data.

2017
- Calculation of heavy metal and PCDD/F emissions from field burning of agricultural residues was revised for the 2017 submission due to inclusion of emission factors from EMEP/EEA Guidebook 2016.

2019
- In response to a question raised during the review, activity data (kg dm burning for specific crop types) has been included in the IIR.

2021
- Activity data for total burned biomass (kt dm) for the whole time series was updated based on the data provided by the Natural Resources Institute Finland (Luke).
- In submissions prior to 2021 the emissions of PCDD/F were calculated with the Tier 1 methodology of the EMEP/EEA Guidebook 2019, whereas all other pollutants are estimated with Tier 2 methodology. Closer inspection of the EF of PCDD/F in the Tier 1 methodology lead to the conclusion that the emission factor is not applicable to the Finnish conditions, as the crop distribution does not correlate to the distribution within the European region. Furthermore, the confidence interval for the EF is not presented, which supports the decision to perform the calculation with the Tier 2 methodology only. Therefore PCDD/F emissions from NFR 3F were removed from the 2019 inventory. Possibilities to include the Tier 2 calculation are studied to the future submissions.

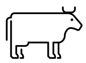
Source-specific planned improvements

None.

5.7 Agriculture other (NFR 3 I)

Not occurring in Finland.

ANNEX I. Example output of the nitrogen flow checking tool: Dairy cows, 2024.



	N-excr.	N-bedding
Dairy cow	kg N/a/head	kg N/a/head
N excr. total	**149,04**	0,2624569
- to slurry	108,98	
- to DL	3,19	
- to FYM	4,79	
- to dung+urine	15,94	
- to pasture	12,60	
- to dry lot	3,53	

N flow calculation for **233541 heads of Dairy cows**

Unit: tonnes of N

	Slurry	DL	FYM	Urine	Dung	Pasture	Dry lot	SUM	CHECK (N left + losses)
Excreted tot-N/head (kg)	108,98	3,19	4,79	9,18	6,76	12,60	3,53	149,04	Excreted tot-N/animal place (kg)
Excreted tot-N	25452,12	744,94	1119,74	2143,57	1578,80	2943,06	824,85	34807,08	Excreted tot-N SUM
Bedding tot-N	61,29	108,96	163,78	0,00	57,44				
Tot-N left	25513,42	853,90	1283,52	2143,57	1636,24	2943,06	824,85	35198,56	
Shift between urine and dung (mixing)				78,94	493,02				
Tot-N left	25513,42	853,90	1283,52	1729,49	2050,32	2943,06	824,85	35198,56	
N losses during housing	2392,48	161,31	48,11	128,50	38,61			2769,01	N losses during housing
as NH3-N	2392,48	74,07	48,11	128,50	38,61			2681,77	NH3-N
as N2O-N	0,00	7,45	0,00	0,00	0,00			7,45	N2O-N
as Nox-N	0,00	2,57	0,00	0,00	0,00			2,57	Nox-N
as N2	0,00	77,22	0,00	0,00	0,00			77,22	N2
Tot-N left	23120,94	692,60	1235,41	1600,99	2011,71	2943,06	824,85	32429,55	Check: 35198,56
Manure tot-N to application after housing	0,00	554,08	0,00	0,00	0,00			554,08	Manure tot-N to application
Tot-N left	23120,94	138,52	1235,41	1600,99	2011,71	2943,06	824,85	31875,48	Tot-N left
Manure tot-N to ad process	231,21	6,93	12,35	0,00	20,12		7	277,36	Manure tot-N to ad process
Manure tot-N to composting	0,00	0,00	0,00	0,00	0,00		0	0,00	Manure tot-N to composting
Tot-N left	22889,73	131,59	1223,06	1600,99	1991,59	2943,06	818,10	31598,12	Check: 35198,56
N losses during filling the manure storage	21,83							21,83	N losses during filling
as NH3-N	21,83							21,83	as NH3-N
as N2O-N	0,00							0,00	as N2O-N
as Nox-N	0,00							0,00	as Nox-N
as N2	0,00							0,00	as N2
Tot-N left	22867,90	131,59	1223,06	1600,99	1991,59	2943,06	818,10	31576,28	Check: 35198,56
N losses from dry lots							149,49753	149,50	›m dry lots
as NH3-N							133,00045	133,00	as NH3-N
as N2O-N							16,49708	16,50	as N2O-N
as Nox-N							0	0,00	as Nox-N
as N2							0	0,00	as N2
Tot-N left	22867,90	131,59	1223,06	1600,99	1991,59	2943,06	668,60	31426,79	Check: 35198,56
Manure tot-N from dry lot	548,25	16,05	24,12	0,00	80,18	0,00	-668,60	0,00	Manure tot-N from dry lot
Tot-N left	23416,15	147,64	1247,18	1600,99	2071,77	2943,06	0,00	31426,79	Check: 35198,56
N losses during storing	1502,97	14,41	208,54	70,72	179,97			1976,62	N losses during storing
as NH3-N	1333,90	6,35	85,31	58,50	69,18			1553,25	as NH3-N
as N2O-N	127,26	0,00	11,20	7,50	19,93			165,88	as N2O-N
as Nox-N	1,35	0,26	3,61	0,15	2,93			8,31	as Nox-N
as N2	40,46	7,80	108,43	4,57	87,93			249,18	as N2
Tot-N left	21913,18	133,23	1038,64	1530,27	1891,80	2943,06	0,00	29450,17	Check: 35198,56
Manure tot-N from ad process	271,26	0,00	0,00	0,00	0,00			271,26	Manure tot-N from ad process
Manure tot-N from composting	0,00	0,00	0,00	0,00	0,00			0,00	Manure tot-N from composting
Tot-N left	22184,44	687,31	1038,64	1530,27	1891,80	2943,06	0,00	30275,50	Check: 35198,56
check	22184,44	687,31	1038,64	1530,27	1891,80				
	119,17	3,85	5,82	5,90	10,96				
N losses during application	2441,42	48,89	74,63	553,45	75,57			3193,95	N losses during application
as NH3-N	2052,04	36,66	56,16	528,91	41,56			2715,34	as NH3-N
as N2O-N	119,17	3,85	5,82	5,90	10,96			145,71	as N2O-N
as Nox-N	270,21	8,37	12,65	18,64	23,04			332,91	as Nox-N
as N2	0,00	0,00	0,00	0,00	0,00			0,00	as N2
N losses during pasturing						241,96748		241,97	N losses during pasturing
as NH3-N						189,8168		189,82	as NH3-N
as N2O-N						16,304361		16,30	as N2O-N
as Nox-N						35,846315		35,85	as Nox-N
as N2						0		0,00	as N2
Losses during AD process	5,21	0,00	0,89	0,00	0,00			6,10	Losses during AD process
as NH3-N	5,21		0,89						as NH3-N
as Nox-N									as Nox-N
Tot-N left	19743,02	638,42	964,00	976,82	1816,23	2701,09	0,00	26839,58	Check: 35198,56
								26839,58	Check: OK
N losses together	6363,91	224,60	332,17	752,67	294,15	241,97	149,50	8358,97	N losses together
as NH3-N	5805,46	117,08	190,47	715,92	149,36	189,82	133,00	7301,10	as NH3-N
as N2O-N	246,43	11,30	17,02	13,39	30,89	16,30	16,50	351,8385	as N2O-N
as Nox-N	271,55	11,21	16,26	18,79	25,97	35,85	0,00	379,63	as Nox-N
as N2	40,46	85,01	108,43	4,57	87,93	0,00	0,00	326,40	as N2
N losses without ad and graz and drylots	6358,70	224,60	331,28	752,67	294,15	241,97	149,50	8352,87	N losses without ad and graz and drylots
Reference value from the calculation sheet	6358,70	224,60	331,28	752,67	294,15	241,97	149,50	8352,87	Reference value from the calculation sheet
Check: losses together OK? DIFFERENCE: (must be zero)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	Check: losses together OK? DIFFERENCE (must be zero)
Inputs tot.	25513,42	853,90	1283,52	2143,57	1636,24	2943,06	824,85	**35198,56**	Inputs tot.
Outputs tot.	26106,93	863,02	1296,18	1729,49	2110,38	2943,06	149,50	**35198,56**	Outputs tot.

ANNEX II. IIR_Chapter_5_Annex_2_Manure_Management_Data_Finland_1980-2024.xlsx is available in the reporting folder **B. Informative Inventory Report – IIR 2026**.