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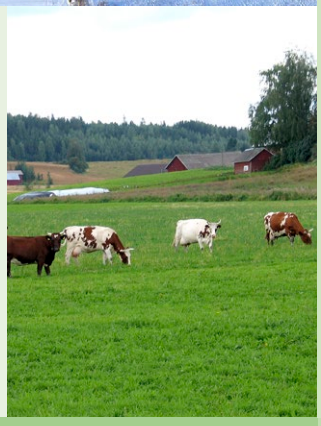
Action plan to reduce ammonia emissions from agriculture in Finland



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Ministry of Agriculture and Forestry
Ministry of the Environment
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Abstract

International agreements and the EU legislation oblige Finland to reduce ammonia emissions into the air. According to the Gothenburg Protocol to the Convention on Long Range Transboundary Air Pollution and the National Emission Ceilings Directive relating to it (2001/81/EC), as from 2010 the annual ammonia emissions in Finland should not have exceeded 31 kilotonnes. Finland has exceeded the emissions reduction obligation by about 20 per cent each year.

The Gothenburg Protocol was amended in 2012 to further reduce ammonia emissions so that from 2020 they should be 20 per cent less than they were in 2005. Within the EU the amendments to the Protocol are implemented by the new National Emission Ceilings Directive (2016/2284).

In Finland more than 90 per cent of the ammonia emissions originate from agricultural sources, which is why most of the actions to reduce the emissions are to be targeted to agriculture. In agriculture, ammonia originates from animal manure in livestock buildings and during storing and spreading of manure. Ammonia volatiles also from other organic fertilisers containing nitrogen, as well as from mineral N- fertilisers.

The most effective measures to reduce ammonia emissions in agriculture concern animal manure and it's management. Ammonia emissions can also be reduced by actions relating to the feeding of animals, but regulating these and assessing the impacts achieved is more difficult than in the case of actions relating to manure management.

This action plan and the measures included in it aim to reduce ammonia emissions from agriculture in a way that the emissions from agricultural sources would meet the obligation set for to the year 2020.

The action plan was prepared in cooperation between the Ministry of Agriculture and Forestry and Ministry of the Environment. The relevant stakeholders were heard during the process.

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Tiivistelmä

Kansainväliset sopimukset ja EU:n lainsäädäntö edellyttävät, että Suomi vähentää ammoniakkipäästöjä ilmaan. Kaukokulkeutumissopimuksen vuoden 1999 Göteborgin pöytäkirjan ja sitä vastaavan EU:n päästökattodirektiivin (2001/81/EY) mukaan Suomen ammoniakkipäästöjen olisi vuodesta 2010 alkaen tullut olla vuosittain korkeintaan 31 kilotonnia. Suomi on ylittänyt päästövelvoitteensa vuosittain noin 20 prosentilla.

Göteborgin pöytäkirjaa muutettiin vuonna 2012 ammoniakkipäästöjen edelleen vähentämiseksi siten, että päästöjen tulisi olla vuodesta 2020 alkaen vähintään 20 prosenttia pienemmät kuin vuoden 2005 päästöt. Pöytäkirjan muutoksen velvoitteet pannaan EU:ssa täytäntöön uudella päästökattodirektiivillä (2016/2284).

Suomen ammoniakkipäästöistä yli 90 prosenttia on peräisin maataloudesta, joten myös pääosa vähennystoimista kohdistuu maatalouteen. Maataloudessa ammoniakkia haihtuu kotieläinten lannasta eläinsuojissa ja lannan varastoinnin ja levityksen yhteydessä. Ammoniakkia haihtuu myös typpeä sisältävistä muista orgaanisista ja epäorgaanisista lannoitteista.

Tehokkaimmat toimenpiteet maatalouden ammoniakkipäästöjen vähentämiseksi liittyvät lantaan, sen varastointiin ja levitykseen. Ammoniakkipäästöihin on mahdollista vaikuttaa myös kotieläinten ruokintaan liittyvillä toimilla, mutta niiden hallinta ja vaikutusten arviointi on lantaan liittyviä toimia hankalampaa.

Tällä toimintaohjelmalla ja siihen sisällytetyillä toimilla pyritään maataloudesta peräisin olevien ammoniakkipäästöjen vähentämiseen niin, että maatalouden ammoniakkipäästöt olisivat vuonna 2020 asetetun velvoitteen mukaiset.

Tämä toimintaohjelma on valmisteltu maa- ja metsätalousministeriön ja ympäristöministeriön välisenä yhteistyönä asiaan liittyviä sidosryhmiä kuunnellen.

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Contents

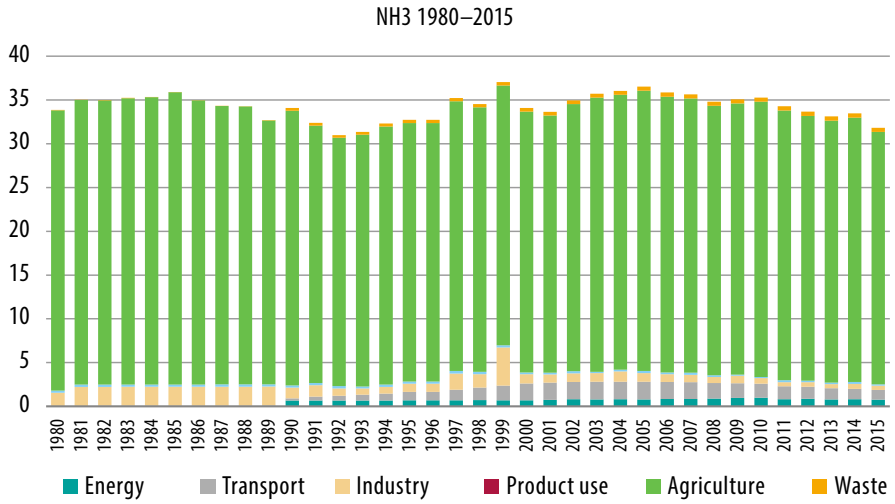
1 Reduction obligations

International agreements and the EU legislation oblige Finland to reduce ammonia emissions into the air. Measures in agriculture needed to comply those international obligations by the year 2020 are expressed in this action plan. The action plan was prepared in cooperation with the Ministry of Agriculture and Forestry and Ministry of the Environment. The relevant stakeholders were heard during the process. The reduction obligations for ammonia emissions in Finland are based on the following documents:

- Gothenburg Protocol to the Convention on Long Range Transboundary Air Pollution (UNECE 1999) and Directive of the European Parliament and of the Council 2001/81/EC implementing the Gothenburg Protocol in the EU (National Emission Ceilings Directive, NEC Directive): ammonia emission ceiling for Finland as from 2010 has been 31 kilotonnes/year.
- Amendment to the Gothenburg Protocol 2012 (UNECE): reduction obligation concerning ammonia emissions from 2020 is 20 percent from the 2005 emission levels (36.5 kt). Ammonia emissions should be reduced by 7.3 kt to the level of 29.2 kt in 2020.
- The amendment of the Gothenburg Protocol obligation will be implemented in the EU by the new NEC Directive (2016/2284). The reduction target for ammonia emissions set for Finland is –20% as from 2020 from the level in 2005.

Trends in ammonia emissions in Finland:

Figure 1. Ammonia emissions in Finland in 1990–2014. (Finnish Environment Institute, 2016)



2 Ammonia emissions from agriculture

In Finland 91 per cent of ammonia emissions come from agriculture, which in this context also includes fur farming (Table 1). In agriculture ammonia evaporates from animal manure in livestock buildings and in the storage and spreading of manure. Ammonia also evaporates from other organic fertilisers containing nitrogen and inorganic fertilisers. In 2015 ammonia emissions from agriculture totalled 28.8 kt, of which 26.5 kt (91.7%) came from animal manure, 2.3 kt (8%) from mineral fertilisers, 0.002 kt from sewage sludge used in agriculture and 0.07 kt from burning biomass on arable land. (Table 2) (Finnish Environment Institute, 2017)

The amount of nitrogen contained in feed that remains unused and ends up in manure depends on the amount and type of protein given in feed and the ability of animals to utilise the protein in feed. The more nitrogen ends up in manure, the greater is the ammonia evaporation potential.

Of the emissions from agriculture about 55% comes from bovines, 15% from pigs, 6% from poultry and 10% from fur animals and 5% from other animals.

In addition to agriculture other sources of ammonia emissions include transport, use of solvents and other products, industry and energy production.

Table 1. Total ammonia emissions and emissions from agriculture in 1990, 2005 and 2010–2015. (Finnish Environment Institute, 2017)

Year	Total emissions (kt)	Agriculture (kt)
1990	34.1	31.4
2005	36.5	32.0
2010	35.3	31.5
2011	34.3	30.8
2012	33.7	30.3
2013	33.1	29.9
2014	33.5	30.2
2015	31.8	28.8

Table 2. Ammonia emissions from agriculture in Finland in 1990, 2005 and 2010–2015. (Finnish Environment Institute, 2017)

year	total (kt)	animals (kt)	fertilisers (kt)	municipal sludge (kt)	burning of agricultural waste (kt)
1990	31.4	27.2	4.1	0.060	0.109
2005	32.0	29.3	2.7	0.004	0.080
2010	31.4	28.7	2.7	0.009	0.050
2011	30.8	28.3	2.5	0.004	0.059
2012	30.3	27.9	2.3	0.007	0.058
2013	29.9	27.6	2.3	0.007	0.078
2014	30.2	27.7	2.4	0.007	0.071
2015	28.8	26.4	2.3	0.002	0.070

Table 3. Ammonia emissions from livestock manure in 2005 and 2015 (kt) by livestock category (Finnish Environmental Institute, 2017).

Animal	2005 (kt)	2015 (kt)	Change 2005–2015 (%)
Dairy cows	9.81	8.47	-14 %
Sucler cows	0.38	0.63	65 %
Heifers	1.79	1.8	1 %
Bulls	2	2.02	1 %
Calves	3.41	2.94	-14 %
Sows with piglets	1.91	1.2	-37 %
Boars	0.03	0.01	-58 %
Fattening pigs	3.02	2.51	-17 %
Weaned pigs	0.72	0.59	-17 %
Laying hens	0.87	0.88	2 %
Cocks	0.01	0.01	46 %
Broilers	0.41	0.58	41 %
Broiler mothers	0.08	0.1	20 %
Chickens	0.15	0.08	-46 %
Turkeys	0.14	0.07	-47 %
Other poultry	0	0	10 %
Horses and ponies	1.1	1.23	12 %
Sheep	0.09	0.23	173 %
Goats	0.01	0.01	2 %
Foxs and racoon dogs	2.52	2.4	-5 %
Minks and polecats	0.76	0.6	-20 %
Reindeer	0.1	0.09	-10 %

3 Steering instruments and measures reducing ammonia emissions from agriculture in Finland

The steering instruments that are currently being used to reduce ammonia emissions from agriculture are:

- Ministry of the Environment: Nitrates Decree and environmental permits; measures included in the river basin management plans
- Ministry of Agriculture and Forestry: Rural Development Programme for Mainland Finland 2014–2020 (environment payments, agricultural investment aids, animal welfare payment and payment to farm advisory services)

Structural development in agriculture also impacts on the levels of ammonia emissions from agriculture.

The most effective measures to reduce ammonia emissions from agriculture concern manure and how it is stored and spread. Ammonia emissions can also be reduced by actions relating to the feeding of animals, but regulating these and assessing the impacts achieved is more difficult than in the case of actions relating to manure. (Grönroos, 2014)

The implementation of the actions to reduce ammonia emissions can be promoted either through statutory means (Nitrates Decree and environmental permits) or measures undertaken by operators on a voluntary basis such as the environment payment scheme.

3.1. Legal measures

3.1.1. Nitrates Decree

The Nitrates Decree amended in 2014 (1250/2014) requires that all slurry and dry manure stores must be covered. Because the requirement applies to new manure stores only and as for bovine slurry, which represents more than 70% of the total amount of slurry produced, natural crust on top is also accepted as cover. The impact of the requirement concerning covering manure stores is estimated to remain quite modest.

The impact of the requirement to cover new and enlarged manure stores on ammonia emissions from agriculture would be about –1%, with the emissions in 2012 as the reference level and not taking account of the fact that nitrogen emissions are likely to grow by 2020 due to the higher output levels, which increases the emissions potential of agriculture.

Manure must be incorporated within 24 hours from the spreading. On sections of arable land parcels with a slope of at least 15% the spreading of slurry, urine and liquid organic fertiliser products by methods other than injection is always prohibited. Other types of manure and organic fertiliser products spread on sloping sections of arable parcels must be tilled into the soil within 12 hours from the spreading.

The impact of the incorporation requirement under the Decree on the total ammonia emissions is about –1%, but this took place immediately after the entry into force of the Decree. The reason for this quite a modest impact is that today a significant share of manure (more than a third of slurry) is spread on vegetation, in which case incorporation cannot be required (except for spreading on vegetation as from 15 September, as also required by the Decree currently in force). Also, already at present a significant share of manure spread on soil with no vegetation or on stubble is incorporated within the required 24 hours.

A farm that receives manure from other farms for storage must have a manure store that can be dimensioned on an annual basis in accordance with the amount of manure received. A farm that receives and stores organic fertiliser products must have a water-tight storage facility dimensioned in accordance with the amount to be received. An organic fertiliser product and manure with a dry matter content of at least 30% can also be stored in covered heaps. Now these requirements for storage, including in heaps, applies to manure as well as organic fertiliser products.

The operator must have the manure analysed every five years to determine its soluble nitrogen, total nitrogen and total phosphorus content. Fertilisation is planned either based on the manure analysis or values presented in the Decree. The operator must keep the

results of the manure analysis and product descriptions of organic fertiliser products and present these to control authorities upon request.

In the autumn from the beginning of September the amount of soluble nitrogen spread in the manure of farm animals and organic fertiliser products may not exceed 35 kg/ha. The whole amount of soluble nitrogen spread in the autumn is taken into account in the fertilisation of the following crop. (Ministry of the Environment, 2014) (Finlex, 2014)

According to the Nitrates Decree, the operator must keep annual records on fertilisation and, upon request, provide this information to the control authority.

The following information is to be included in the records:

1. amount of manure and organic fertiliser products and nitrogen fertilisers used as nutrient supplements in arable lands and the soluble nitrogen and total nitrogen contained in these;
2. yield levels;
3. time when manure or organic fertiliser products were spread on arable lands.

3.1.2. Environmental permit for livestock premises

According to the Environmental Protection Act (527/2014), a permit is required for any activities that pose a threat of environmental pollution. The permit requirements for livestock premises are based on the keeping of livestock in the premises, which comprises the exercise and grazing areas and the storage, handling and utilisation of the manure, liquid manure and wastewater produced in them. Provisions on restricting ammonia emissions may also be included in the environmental permit. Such provisions are needed to reduce harm to the environmental and health caused by the odour and air emissions and to comply with the international obligations (Gothenburg Protocol and National Emission Ceilings Directive). The provisions in the environmental permit may also be stricter than those in the Nitrates Decree concerning, for example, more rapid incorporation of manure (within 4 hours, for example) and fixed covers on manure stores (including the existing ones). The permit may also require that slurry may only be spread by injection or that spreading in windy conditions should be avoided.

The provisions in the permit must be based on the best available techniques, but the use of a specific technique cannot be required.

Pig and poultry production units that fall within the scope of the Industrial Emissions Directive apply the BAT conclusions concerning these sectors, which also include requirements concerning ammonia emissions. Of the emissions from livestock production (which repre-

sent about 86% of the total emissions) 65% come from units that are subject to the permit (all cattle, pig, poultry, etc. production units that are subject to the permit). The share of production units covered by the Industrial Emissions Directive (large pig and poultry production units) of the emissions from livestock production is estimated to be about 3%.

3.2. Rural Development Programme for Mainland Finland 2014–2020

3.2.1. Environment payment for injection of slurry into the soil

The most effective measure of the Rural Development Programme to reduce ammonia emissions is the parcel-specific measure concerning injection of slurry into the soil included in the environment payment scheme. The measure has been applied in Mainland Finland since 2009.

Table 4. Trend in the number of farms that have undertaken the measure and the area covered in 2009–2015.

Year	Number of farms	Area where slurry injected into the soil, ha
2009	1,482	50,330
2010	2,046	73,810
2011	2,566	94,231
2012	2,897	112,749
2013	2,919	119,410
2014	2,919	119,410
2015	5,300	217,000
2016	5,150	186,000

In this five-year commitment the farmer is paid compensation for using the injection method when spreading slurry or urine. The payment of the compensation requires that per hectare is spread at least 20 m^3 / year.

In the aid application of spring 2015 the measure was selected by 12,500 farms (about 400,000 ha), of which about 5,300 farms had used it on an area of about 217,000 hectares in that year. The payment is 40 €/ha. This means that under the measure concerning the injection of slurry into the soil at least 4,340,000 m^3 (20 m^3/ha x 217,000 ha) of slurry had been injected into the soil, which is almost half of the total amount of slurry produced (9.5 million m^3; Luostarinen et al. 2017). In reality the share of manure that is injected is even greater because all farms that spread slurry do not participate in the environment payment scheme or have not selected this measure. The amount spread per hectare is also likely to be larger than the minimum of 20 m^3/ha specified in the conditions. Thus the

share of slurry injected into the soil of all slurry produced in 2015 is estimated at about 55%. In 2014 about a third of all slurry spread was injected into the soil. The amount of slurry injected in 2016 was theoretically slightly lower than in 2015. Injected amounts are influenced also by the weather conditions of each year and the crop range in the crop rotation.

The impact of increased injection of slurry into the soil on emissions depends on the method by which slurry was applied before the injection method was introduced. In 2014 about a third of the slurry was injected, about 27% was applied by trailing hose spreading and about 40% by broadcasting. Of the slurry produced in Finland every year about a third comes from cattle production and the rest from pig husbandry. Cattle slurry is also com monly applied on grasses, which is why injection is a little more common than in the case of pig slurry, while hose spreading is more common on pig farms because pig slurry is often applied on new plant shoots as well.

Compared to broadcast application and assuming that slurry is not incorporated after application, injection reduces ammonia evaporation by about 80%, on average (injection close to surface less, deeper into the soil more). Correspondingly, the impact of hose spreading on reducing emissions would be about 30–35% (emissions reduced more when applied on vegetation).

According to our national legislation (Nitrates Decree 1250/2014), manure spread on land surface must be incorporated within 24 hours, unless it is a question of manure spread on growing vegetation. This means that part of the manure applied by means of trailing hose spreading or broadcasting is incorporated after application by ploughing or harrowing. The impact of incorporation on reducing emissions varies between 15 and 90% depending on the method used and how quickly after application the manure is incorporated.

When estimating the impact of the growing use of the injection method on reducing emissions in 2015 it was assumed that the share of manure applied by injection increased from 33% in 2014 to 55% in 2015. This was estimated to have resulted in a slight reduction in the share of trailing hose spreading (27% → 25%) and a more significant reduction in the share of broadcast application (40% → 20%). No change was assumed to have taken place in how quickly after application the manure was incorporated.

The increased use of injection into the soil reduced ammonia emissions from agriculture by about 1.25 kt from 2014 to 2015.

Measure: Support for manure spreading by the injection method is continued as part of the environment payment scheme in 2017–2020.

In 2017–2020 the share of manure spread by injecting it into the soil stays at a high level or increases. The updated BAT conclusions concerning the intensive rearing of pigs and poultry (IRPP) will further increase the share of manure spread by injection because broadcast application is no longer compliant with the Best Available Techniques. The new BAT conclusions entered into force in the first half of 2017. As a result of other changes in manure spreading mainly increased use of hose spreading for slurry, the emissions from manure are estimated to decrease by about 2.6 kt from 2014 to 2020.

3.2.2. Agricultural investment aid

Investments enhancing the state of the environment

Covering manure stores and cooling manure channels is eligible for support under the agricultural investment aid scheme. In the programming period 2014–2020 support may also be granted for other investments to improve the state of the environment (section 18 of the Government Decree on Targeting Agricultural Investment Aid 241/2015). This comprises, among other things, support for the acquisition of equipment for the separation and other treatment of manure and for injecting slurry into the soil. In 2016 aid was granted for 60 purchases of slurry injection equipment and for 8 purchases of manure separation equipment. Cooling of manure channels is usually always taken into account in new construction projects in piggeries, but is also supported as separate projects. For 2016 the aid percentage of investments relating to improving the state of the environment was raised from 30 to 35% and in investments to slurry injection equipment to 40 %.

In 2000–2016 a total of about 6 600 manure stores (table 5) were built by means of the investment aid, with a total volume of almost 8.6 million m^3 and the surface area of stores with fixed covers of 660,000 m^2. The manure storage volume of uncovered manure stores built by means of investment aid was 6.4 million m^3 and that of covered manure stores was about 2.2 million m^3 (Table 6).

Table 5. Numbers of manure stores and covered manure stores built by means of investment aid in 2000–2016.

Year	Number of stores for solid manure	Of these covered	Number of slurry tanks	Of these covered	Number of liquid manure tanks	Of these covered
2000–2001	548	237	490	100	127	36
2002	311	119	330	73	60	15
2003	258	99	301	86	44	11
2004	195	87	188	35	27	6
2005	296	129	310	72	61	18
2006	229	92	279	56	37	15
2007	236	100	337	50	37	14
2008	96	57	162	30	7	2
2009	102	55	214	34	13	8
2010	70	28	176	33	12	3
2011	58	31	146	24	4	0
2012	52	32	116	20	2	2
2013	80	33	140	27	8	8
2014	43	24	89	6	2	1
2015	68	38	52	1	2	1
2016	108	85	109	5	3	0
total	2,750	1,246	3,439	652	446	140
share%		45.3		19.0		31.4

Table 6. Volumes (m^3) of manure stores and covered manure stores built by means of investment aid in 2000–2016.

Year	Stores for solid manure m^3	Of these covered m^3	Slurry tanks m^3	Of these covered m^3	Liquid manure tanks m^3	Of these covered m^3
2000–2001	264,941	114,582	506,602	103,388	46,170	13,088
2002	205,365	78,580	422,202	93,396	24,670	6,168
2003	151,221	58,027	446,776	127,650	13,138	3,285
2004	159,003	70,940	280,974	52,309	9,433	2,096
2005	204,697	89,209	465,727	108,169	21,524	6,351
2006	186,158	74,788	525,832	105,543	12,215	4,952
2007	273,474	115,879	683,215	101,367	11,824	4,474
2008	121,074	71,888	323,103	59,834	4,150	1,186
2009	90,285	48,683	510,746	81,147	4,160	2,560
2010	74,111	29,644	435,448	81,647	4,953	1,238
2011	98,376	52,580	334,275	54,949	990	0
2012	55,247	33,998	346,795	59,792	715	715
2013	75,354	31,084	331,832	63,996	2,585	2,585
2014	44,681	24,938	229,420	15,467	912	456
2015	130,286	65,506	116,665	2,500	4,448	2,114
2016	122,709	98,786	258,469	7,103	756	0
total	2,256,982	1,059,112	6,218,081	1,118,257	162,643	51,267
share%		46.9		18.0		31.5

In 2014 about 70% of cattle slurry was not covered or had formed a natural crust. Of pig slurry 40% was stored in uncovered tanks. Of dry manure about 60% was in uncovered manure stores. The share of manure stored in covered stores is going to increase due to the requirement concerning covering new manure stores in the amended Nitrates Decree from 2014 (1250/2014), but this change will be quite slow. Covering will also become increasingly common upon the entry into force of the updated BAT conclusions concerning the intensive rearing of pigs and poultry (IRPP).

The Nitrates Decree's requirement to cover manure stores is estimated to result in only a slight reduction in ammonia emissions from agriculture, less than 1 kt, in 2014–2020. In large slurry stores for cattle the formation of a natural crust is usually considered sufficient. In pork production slurry stores are usually covered with floating cover. Solid manure stores are covered with roofs.

Measure: Investment aid continues to be granted for covering manure stores, cooling manure channels and acquisition of manure treatment equipment as well as to other investments promoting the environment.

3.3. Other measures to reduce ammonia emissions

The following chapters present measures which have only a minor impact on ammonia emissions and the impact is difficult to measure, but which have some potential to reduce the emissions.

3.3.1. Environment payments

Balanced use of nutrients

The measure concerning balanced use of nutrients is a farm-specific measure included in the environment payment scheme under the Rural Development Programme for Mainland Finland 2014–2020. It includes the maximum use levels for nitrogen and more detailed conditions for the use of cattle manure with regard to the quantities and the times of spreading. Farmers are also required to keep detailed parcel-specific records on measures undertaken on arable lands. The conditions must be complied with on all arable lands of a farmer who has given the five-year commitment. The compensation paid for the measure is 54 €/ha/year.

Nitrogen fertilisers may be used for specific plants and based on the circumstances of each parcel in amounts per hectare that are below the use levels allowed by the current legislation (legislation on fertiliser products and Nitrates Decree). Nutrients contained in animal

manure are taken into account in fertilisation in accordance with the strict restrictions for nitrogen.

In 2015 about 45,600 farms made the environment commitment, covering a total arable area of about 2.06 million ha. This is 86% of all farms that applied for direct payments. About 44,000 farms has the environmental commitment. The commitment covers 2.06 million ha of fields which is almost 90% of the total field area of farms applying for direct aid.

The total area covered by the measure concerning balanced use of nutrients is more than 1.8 million ha. The measure restricts the use levels of nitrogen as fertiliser (fertiliser products and animal manure) to a level below that specified in the current legislation. Changes in the use of mineral nitrogen are followed via the statistics on fertiliser sales.

Measure: Support for balanced use of nutrients continues to be paid in 2017–2020.

3.3.2. Payment to farm advisory services

The measure concerning advisory services under the Rural Development Programme contributes, in particular, to reducing excessive protein feeding by monitoring the nutrient balances with regard to feeding (utilisation of nitrogen). Advice is also provided on the impact of feeding and output levels of the animals on ammonia emissions. In environmental advice efforts are made to influence the nutrient balances of a livestock farm as a whole. To achieve this, action is needed regarding the supplementary training of advisers and the materials used in the training. Advice is also needed on crop farms using manure and organic fertiliser products as a source of nutrients for plants.

Measure: Advisory services stress the importance of reducing excessive protein feeding in the effort to reduce ammonia emissions and of optimising the handling, storage and spreading of manure.

3.3.3. Animal welfare payment

Some of the measures in the animal welfare payment scheme are such that they contribute to reducing ammonia emissions, at least indirectly. The written feeding plan based on calculations for specific groups of animals required under the measure concerning the feeding and care of bovines, pigs and poultry must take account of the growth of the animal and its output level and production stage. Feed analysis must be conducted on roughage for bovines and sheep. Quantities of milk produced by dairy cows and goats must be measured and protein analysis must be conducted on supplementary cereal for poultry. The measure concerning feeding and care was selected by a total of 5,564 farms.

For egg producing farms there is a measure to improve the air quality of laying hen units where manure is removed from the premises three times a week. The ammonia level in the air of the unit must be recorded on a weekly basis, and a ceiling has been set for this. A total of 85 farms have selected this measure.

There is also a measure concerning the grazing and exercise for bovines, sheep and goats, which may be eligib le for the aid concerning the grazing of animals during pasture season, exercise outside the pasture season and extending the grazing season. Records must be kept on the grazing and exercise.

In the animal welfare payment scheme there are also conditions that require more abundant use of bedding in the pens.

Measure: The animal welfare payment scheme is continued in 2017–2020.

3.3.4. Acid treatment of manure

In the future there may also be new technologies available for reducing ammonia emissions. Acid treatment of manure is being used in Denmark and studies on this are under way in Finland as well. Acidification of manure may take place in the livestock premises, slurry basin (storage tank) or in connection with spreading on arable land. Acidification may reduce ammonia emissions 20–80% depending on, for example, the stage of processing in which the acid is added to manure. (Salo et al., 2015)

Measure: Studies on the applicability of the acidification method and its impacts on ammonia emissions in the Finnish conditions are continued.

4 Structural development in agriculture

There have been significant structural changes in Finnish agriculture since Finland joined the EU in 1995. In 1995 there were 95 562 farms in Finland, but in 2016 this number was only about 51,600. This means that the number of farms had fallen by more than 45%. As the number of farms has decreased their average size has grown from 22.8 hectares of arable land in 1995 to 44 hectares in 2016. (Niemi & Väre, 2017)

In recent years the change in the production structure of agriculture has been characterised by the decrease in the number and share of livestock farms and growth in the share of crop farms. The number of dairy farms, for example, fell from 31,000 farms in 1995 to 7,318 farms in 2016, while during the same period the number of dairy cows decreased from 398,500 to 282,500. For example between 2005 and 2012 the number of dairy cows fell by about 10% (Niemi & Väre, 2017). However, during this period the ammonia emissions from dairy cows decreased by only 7% as nitrogen excretion increased by 9% due to the higher output level.

In the next few years the strong structural development is expected to continue in livestock production. The number of dairy farms is forecast to decrease from the present about 7,700 farms to 5,200 farms by 2020, while the number of pig farms is expected to fall from 790 to about 700. The farms that quit production are smaller and their profitability is weaker. Very likely their manure stores are not covered, which means that uncovered manure stores will also become less common. At the same time the farms that expand their production are obliged to cover the manure stores as they are making new investments. The remaining livestock units are larger in size and their operations are more resource-efficient. Many of the operations that require special machinery and major investments in machines are outsourced to other entrepreneurs and contractors. Some farmers may also sell machine contracting services to other farmers. This means that many of the operations relating to the handling of manure will be carried out more efficiently and with better professional skill, which reduces the loss of nitrogen, including ammonia emissions.

The high financial risks involved as the production units grow in size cause the farmers to work even more professionally than before, with the aim to minimise losses and waste and

optimize the economic result. This means that careful optimisation of feeding will also become increasingly common. The change in the operating culture associated with the larger unit size and outsourcing of works contribute to reducing nitrogen losses. The relevant structural changes in this context include changes in the number of animals, the amount of nitrogen excreted in animal manure, and size of the production units, resulting in wider use and better systems for managing slurry, covering of slurry stores and development of manure spreading systems where less ammonia is caused to evaporate. These structural changes together with the legislative changes (the Nitrates Decree, in particular), targeting of the environment payment scheme, investment aid and increased advisory services and training, research and cooperation projects will make a significant contribution to reducing ammonia emissions. In ammonia reduction examination it is taken into account the development of estimates of animal numbers and changes in manure management in 2020. About these the decrease of animal numbers is expected to reduce agricultural ammonia emissions by approximately 1 kt 2014–2020. Nitrogen excretion of animals is estimated to remain unchanged.

5 Fur farming

5.1. Production

Fur production is strongly concentrated to certain regions of Finland, with most of the farms located in Ostrobothnia. The production is concentrated within these regions as well. The trend in the size of fur farms is similar to that of other farms: the number of farms is decreasing but the volumes produced stay about the same. Now there are about 950 fur farms in Finland, most of them representing the size classes where an environmental permit is required. Of the ammonia emissions about 10% originate from fur production.

In most cases fur farms have no arable land of their own. Manure is utilised under contracts with other farms which receive the manure and use it as fertiliser. Another common option is to take the manure to a composting plant, but considering the operations in the area there are quite few composting plants or other plants that treat animal manure. The amounts of manure from fur farms represent quite a small share of the total amount of manure produced by farmed animals, but fur animal manure is very rich in nutrients and it is being produced in areas where there is a lot of manure from livestock farms as well.

In Finland fur animals are mainly raised in open-sided sheds, where concrete structures are now being replaced by other types of leak-tight floors. On some mink farms animals are now raised in halls, but this has not become very common due to the high building costs. Open-sided sheds with earth floors are also still in use, with intensified environmental protection measures laid down for these in the environmental permit.

At present an estimated 45% of the fur farms have leak-tight floors and treatment systems for runoff water have been constructed on about 75% of the large and 60% of other fur farms. Leak-tight floors are installed when new premises are built or old ones renovated. In Finland there are also joint fur farming areas with joint composting plants for fur animal manure.

5.2. Steering instruments and measures reducing ammonia emissions

5.2.1. Legal measures

Environmental permit

The environmental permit of a fur farm lays down provisions regarding, for example, the removal and storage of manure. In the case of foxes manure must be removed once or twice a year and in the case of minks 3 to 4 times a year. The environmental permit requires that all farms use enough bedding, either chopped straw or peat, under the open-sided animal sheds. In fur farming manure removal techniques and design of equipment are still quite undeveloped.

Nitrates Decree

The storage requirements for fur animal manure are regulated by the Nitrates Decree. Manure must be stored in a storage facility with a sufficient capacity to store manure produced during a period of 12 months. According to the Nitrates Decree, all new manure stores must be covered. Regulations on manure spreading in the Nitrates Decree also apply to fur animal manure.

5.2.2. Other measures

Environmental protection guide

The Ministry of the Environment is preparing an environmental protection guide for fur farming, including measures to reduce ammonia emissions from the handling and storage of manure. The guide will also be used in the provision of advice.

Measure: An environmental protection guide is prepared for fur farming.

Payment to farm advisory services

The measure concerning farm advisory services in the Rural Development Programme for Mainland Finland may contribute to reducing ammonia emissions from fur farming as well. Knowledge on the climate impacts of fur farming should be enhanced by providing further training and teaching material for advisers.

Measure: More advice is provided on climate protection in fur farming, with particular focus on means to reduce ammonia emissions in the handling and storage of manure.

Research

More research is needed on the environmental impacts of fur farming, means to reduce the harm and their costs, and utilisation of fur animal manure.

6 Action plan to reduce ammonia emissions from agriculture in Finland in 2017–2020

This action plan applies only to the reduction of ammonia emissions from agriculture. In Finland the ammonia emission reduction obligations are based on international commitments on the reduction of emissions into the air (see Chapter 1). Ammonia emissions in Finland should not exceed 31 kt per year. The emissions reduction obligation has been in force since 2010. In 2015 ammonia emissions were 31.8 kt, of which the share of agriculture was 28.8 kt.

Both total ammonia emissions and agricultural emissions have had a slight downward trend throughout the 2010s with the exception of 2014 (Table 1). The need to reduce ammonia emissions from agricultural sources is about 5.5 kt. From 2020, the emission reduction obligation will become relative instead of being considered in absolute terms. The ammonia emission reduction commitment for Finland is 20% compared to the emissions in 2005.

An updated agricultural emission model has been utilised in the preparation of the action plan (Grönroos et al. 2017).

The most significant measures to reduce ammonia emission are the following:

- spreading of slurry and urine by injection, and band spreading
  - Initial level: In 2012 ca. one third of slurry and urine was spread by injection, while the share of band spreading was about a quarter.
- covering manure stores
  - Initial level: In 2012 ca. 55 % of the storage volume of pig slurry was covered. Of the bovine slurry ca. a quarter was covered with a fixed or floating cover and the rest was covered with natural crust. The situation is assumed to have been about the same in 2014.

In addition, ammonia emissions in 2017–2020 will be influenced by technological and structural development in agriculture, intensified/improved nutrient recycling measures under the Government Programme, more accurate feeding and measures in fur production. The change in animal numbers is estimated to reduce ammonia emissions by about 1.0 kt 2014–2020. The impact of improved nutrient recycling and more accurate feeding on ammonia emissions were not estimated here.

Table 7 summarises the measures to reduce ammonia emissions in 2017–2020.

Table 7. An action plan to reduce ammonia emissions from agriculture from 2017 to 2020. Ammonia emissions from agriculture were 30.2 kt in 2014 and in 2020, they would be 26.6 kt (-3.6 kt).

Year	Measure	Tool	Cumulative reduction (total and split*) 2014 as reference (kt)	Total agricultural emissions kt
2014	• 33% of slurry and urine injected • 27% of slurry and urine applied by band spreading • Manure spread on soil surface was mainly incorporated within 24 hours • Ca. 55% of pig slurry storage volume was covered • Ca. quarter of bovine slurry was stored under fixed or floating cover, the rest was covered with natural crust			30.2
2015	• 55% of slurry and urine injected • 25% of slurry and urine applied by band spreading • Manure spread on soil surface incorporated within 24 hours • Covering manure stores	• Injection of slurry, covering manure stores (investment aid) • Nitrates Decree	1.4 kt – an: 0.12 kt – cov: 0.03 kt – app: 1.25 kt	30.2-1.4=28.8
2016	• 60% of slurry and urine injected • 30% of slurry and urine applied by band spreading • Manure spread on soil surface incorporated within 24 hours • Covering manure stores	• Injection of slurry, covering manure stores (investment aid) • Nitrates Decree	1.8 kt – an: 0.24 kt – cov: 0.06 kt – app: 1.50 kt	28.8-0.4=28.4
2017	• 60% of slurry and urine injected • 30% of slurry and urine applied by band spreading • Manure spread on soil surface incorporated within 24 hours • Covering manure stores	• Injection of slurry, covering manure stores (investment aid) • Nitrates Decree	2.2 kt – an: 0.36 kt – cov: 0.09 kt – app: 1.75 kt	28.4-0.4=28.0
2018	• 65% of slurry and urine injected • 30% of slurry and urine applied by band spreading • Manure spread on soil surface incorporated within 24 hours • Covering manure stores	• Injection of slurry, covering manure stores (investment aid) • Nitrates Decree	2.7 kt – an: 0.48 kt – cov: 0.12 kt – app: 2.10 kt	28.0-0.5=27.5
2019	• 65% of slurry and urine injected • 30% of slurry and urine applied by band spreading • Manure spread on soil surface incorporated within 24 hours • Covering manure stores	• Injection of slurry, covering manure stores (investment aid) • Nitrates Decree	3.1 kt – an: 0.60 kt – cov: 0.15 kt – app: 2.35 kt	27.5-0.4=27.1
2020	• 70% of slurry and urine injected • 30% of slurry and urine applied by band spreading • Manure spread on soil surface incorporated within 24 hours • Covering manure stores	• Injection of slurry, covering manure stores (investment aid) • Nitrates Decree	3.6 kt – an: 0.72 kt – cov: 0.18 kt – app: 2.70 kt	27.1-0.5=26.6

* abbreviations: an = animal numbers; cov = manure stores covered; app: manure application measures

7 Monitoring of the action plan

Agricultural and environmental authorities jointly monitor the realisation of emission reductions on an annual basis. Farms participating in the environment payment scheme (86% of the farms that applied for support payments) declare the amounts of manure applied by injection to the agricultural authorities each year. Agricultural investment aid also aims to guide farmers to invest in solutions that reduce emissions. Investments in covering of manure storages are being monitored and recorded on an annual basis according to both the size and volume of manure stores.

The evaluation of the Rural Development Programme provides information on how much the measures under the programme reduce ammonia emissions (sample study). These estimates will be available in summer 2019 as part of the expanded annual report on the programme.

To ensure the achievement of emission reductions, farmers are told about the changes in the operating environment, new research findings and measures to reduce emissions and encouraged to adopt these. Farm advisory services have a significant role in this, and more advice will be provided and targeted in a way that reductions in ammonia emissions can be achieved. At present most of the environmental measures, such as manure injection, are voluntary, but if the obligations are not met, other options for reducing emissions will have to be considered.

8 Compliance with the reduction obligations

When ammonia emissions from agriculture are reduced as set out in Table 7, these emissions will be 26.6 kt in 2020. However, this emission estimate does not include all the expected changes in agriculture, such as changes in nitrogen excretion of animals and in the use of mineral nitrogen fertilizers. Considering the estimated changes in these factors, agricultural emissions would be somewhat higher than the above mentioned 26.6 kt. Nevertheless, the total emissions of ammonia in Finland in 2020 would be around 29.6 kt, which is very close to the 2020 obligation – 20% of 2005 emissions (29.2 kt). It is estimated that emissions will continue to decline after 2020, mainly as a result of reduction in animal numbers.

9 Emission inventories adjustment

The so-called emission inventories adjustments are taken into account when assessing compliance with the emission reduction obligations. Countries can apply for the inventory adjustment from the implementing body of the Gothenburg Protocol to the ECE Convention on Long Range Transboundary Air Pollution, if their calculation methodology or emission factors have changed due to scientific advancement, causing emission requirements to be exceeded. Changes in the operations are not eligible for inventory adjustments. The ECE has approved applications of Finland concerning adjustments in ammonia emissions for small-scale combustion and transport, but not for agriculture. The adjustments are shown in Table 8. The approved adjustment is valid for a certain number of years, in this case until 2020. Reporting on the approved adjustment must be done on an annual basis, and if there are any changes in the method a new application for adjustment must be submitted. In the future the adjustment is likely to also be applicable to the obligations under the NEC Directive. With the development of emission inventories, the emissions have fallen faster than anticipated and no adjustments are likely to be needed in the future.

Table 8. Adjustment of ammonia emissions in Finland 2010–2014.

Approved adjustments		2010	2011	2012	2013	2014
NH_3	kt	– 2.05	– 1.85	– 1.85	– 1.72	– 1.57

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