COMPASSION
in world farming

The Ammonia Pollution Problem

An interconnected crisis demands a One Health perspective

Foreword

Ammonia pollution has emerged as one of the most pressing – and least recognised – environmental and public health challenges of our time. Although ammonia is essential for food production, its release into the atmosphere has become overwhelmingly driven by one sector: agriculture. Today, livestock production and fertiliser use account for more than 80% of global ammonia emissions, making agriculture by far the dominant source of this pollutant. This reality is not incidental; it is the direct result of a rise in intensive farming systems that concentrate animals, fertilisers, and waste at scales far beyond what the ecosystem can absorb.

Ammonia is a reactive nitrogen gas and the foundational ingredient for nearly all nitrogen-based fertilisers. While it plays an important role in food production, it becomes a problem when too much of it is released in the environment. Intensive farming systems introduce far more reactive nitrogen than the environment can absorb, through nitrogen-based fertilisers and animal manure and urine. When this nitrogen is converted into ammonia and evaporates into the atmosphere, it no longer acts as a nutrient but as a pollutant. In the air, ammonia reacts with other compounds to form fine particulate matter ($PM_{2.5}$), which is especially harmful because these tiny particles can penetrate deep into the lungs and bloodstream, driving serious health impacts and contributing to widespread environmental damage.

The consequences are most acute in regions where agricultural intensification is highest. Areas with dense livestock operations or heavy fertiliser use experience disproportionately high ammonia emissions, which in turn lead to elevated levels of nitrogen deposition, degraded ecosystems, and dangerous concentrations of $PM_{2.5}$. These hotspots illustrate a simple truth: where agriculture is intensified, the environmental and health burdens of ammonia intensify with it. In the UK, this pattern is stark. Agriculture is responsible for 89% of national ammonia emissions, and these emissions play a major role in driving $PM_{2.5}$ pollution across both rural and urban areas.

> ***Livestock production and fertiliser use account for more than 80% of global ammonia emissions.***

Ammonia pollution has far-reaching environmental impacts once it enters the atmosphere. It reacts with other air pollutants to form $PM_{2.5}$ and contributes to poor air quality, while the nitrogen it carries is eventually deposited back onto land and water. This excess nitrogen can acidify soils, fuel algal blooms, and shift ecosystems toward species that tolerate high nitrogen levels, undermining the health of forests, grasslands, wetlands, and freshwater habitats.

Ammonia emissions are also closely tied to the conditions in intensive livestock systems. High stocking densities and large volumes of manure create environments where ammonia builds up, exposing animals to air that irritates their eyes and respiratory systems and increases stress and disease risk.

The health implications of ammonia pollution are profound. Globally, ammonia is responsible for nearly 40% of $PM_{2.5}$ formation, making it one of the most significant contributors to air pollution worldwide. Exposure to $PM_{2.5}$ is associated with heart disease, stroke, chronic respiratory illness and lung cancer. In communities near intensive livestock operations or heavily fertilised croplands, these risks are magnified, creating a public health burden that extends far beyond farm boundaries. UK specific evidence underscores this burden: in 2010, an estimated 15,470 deaths were attributed to $PM_{2.5}$ exposure. Modelling shows that reducing agricultural emissions could dramatically reduce mortality, with a 50% reduction lowering deaths by 21%, and complete removal of agricultural emissions reducing $PM_{2.5}$ related mortality by up to 93%.

This interconnected crisis – spanning animal welfare concerns, environmental degradation and human health impacts – demands a One Health perspective. Ammonia pollution is not simply an agricultural issue but a systemic challenge that directly affects animals, people, and the planet, making it essential to rethink how food is produced and how nitrogen is managed within safe ecological limits. The evidence shows that cutting ammonia emissions is both an environmental necessity and a critical public health intervention. Confronting this pollution head-on is vital if we are to build a food system in which animals, communities, and ecosystems can all thrive.

How has ammonia become a pollution issue?

Nitrogen is vital for life. It is required for the synthesis of proteins, DNA, and other essential molecules in living organisms. However, most nitrogen on Earth exists in forms that living organisms cannot use directly, particularly as inert nitrogen gas (N_2) in the atmosphere (Nieder & Benbi, 2021). For most of human history, biologically available nitrogen came mainly from nitrogen-fixing microbes, and this natural scarcity of nitrogen constrained food production (Nieder & Benbi, 2021).

During the 20th century, humans fundamentally altered the nitrogen cycle, developing a process to convert atmospheric nitrogen into biologically available nitrogen, particularly ammonia, enabling the mass production of synthetic fertilisers (Nieder & Benbi, 2021). Together with increased livestock production and land-use changes, this innovation dramatically increased the amount of reactive nitrogen circulating in the environment. While this transformation has been essential for supporting global food production, it has also led to large emissions of ammonia into the atmosphere, as nitrogen from fertilisers and manure is volatilised and mobilised more rapidly than can be incorporated into biomass (Nieder & Benbi, 2021).

Once released into the atmosphere, ammonia no longer functions as a nutrient but as an air pollutant (Behera et al., 2013). It contributes to biodiversity loss through eutrophication and soil acidification, drives air pollution via the formation of fine particulate matter, and disrupts climate processes through interactions with greenhouse gases and atmospheric aerosols (Sutton et al., 2008). As a result, human-driven nitrogen use has pushed the Earth system into a high-risk zone for the nitrogen planetary boundary (Steffen et al., 2015).

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Agricultural nitrogen as a source of ammonia pollution

The largest source of ammonia (NH_3) emissions is agriculture, including animal husbandry and NH_3-based fertiliser applications, which together account for over 80% of global ammonia emissions (Wyer et al., 2022).

In livestock systems, most nitrogen consumed by animals is excreted in manure and urine, which are the primary sources of ammonia. Microbial processes convert this nitrogen into ammonia, which is then released to the atmosphere at multiple points along the production chain, including animal housing, manure storage, grazing land, and during land application of manure. As a result, livestock production is a continuous, spatially concentrated source of ammonia emissions.

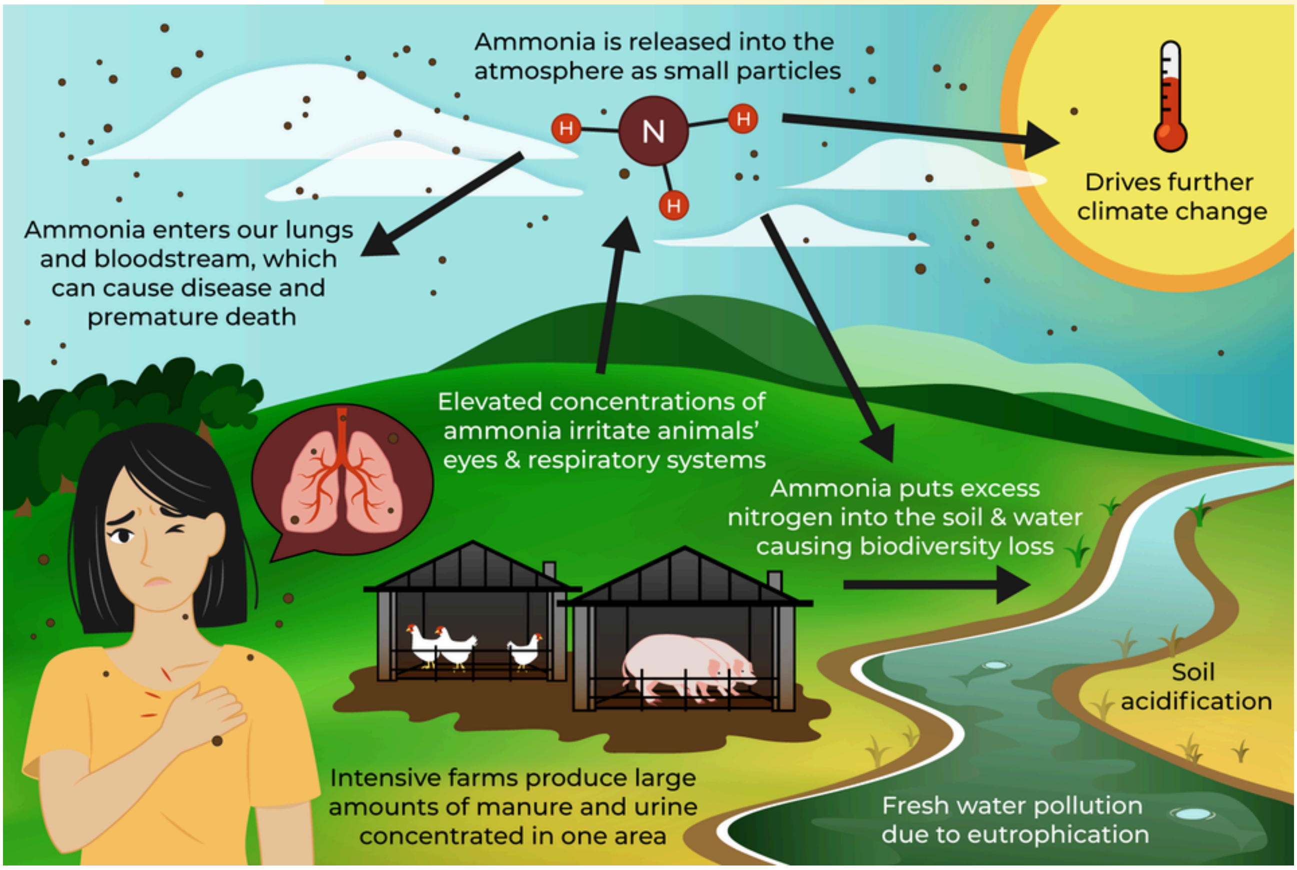
The second major source is fertiliser use. When synthetic or organic nitrogen fertilisers are applied to agricultural soils, a fraction of the nitrogen is lost as ammonia gas rather than taken up by crops. Emission rates depend strongly on application methods, timing, and weather conditions, with surface application and warm conditions leading to higher losses.

Non-agricultural sources account for only a minor fraction of total ammonia emissions. Natural sources such as oceans and biomass burning account for roughly one-third of global emissions (around 16% and 17%, respectively), while other anthropogenic non-agricultural sources, including industry, transport, and waste treatment, contribute only about 2% of global ammonia emissions (Bauer et al., 2016).

Fertiliser application

Ammonia pollution as a One Health challenge

One Health is an integrated approach that recognises the interdependence between human, animal, and ecosystem health (Winkler et al., 2025). This multidisciplinary and multisectoral approach enables more effective monitoring of emerging risks and the design of more integrated prevention and response strategies. Ammonia pollution from agriculture illustrates this interdependence clearly, as emissions generated in livestock and fertilised cropping systems simultaneously affect ecosystems, animals, air quality, and human health (Goldberg, 2016; Kanter, 2018; McCubbin et al., 2002; Wyer et al., 2022).



Ammonia pollution from factory farms harms humans, animals and our planet.

Environmental impacts of ammonia pollution

Ammonia emissions from agriculture have a wide range of environmental consequences once released into the atmosphere. For example, ammonia interacts with other atmospheric molecules to generate secondary pollutants, such as fine particulate matter ($PM_{2.5}$), and contributes to the generation of surface ozone, therefore negatively impacting air quality (Luo et al., 2025). Moreover, ammonia in the atmosphere is eventually deposited back into terrestrial and aquatic ecosystems via wet and dry deposition. This nitrogen deposition may lead to soil acidification, eutrophication of freshwater and marine habitats, and biodiversity loss by promoting nitrogen-tolerant species over vulnerable ones (Luo et al., 2025). These changes alter ecosystem structure and function, potentially degrading ecosystems, including forests, grasslands, and wetlands (Luo et al., 2025).

Agricultural nitrogen emissions also contribute to climate change. Nitrous oxide (N_2O), a gas released from fertilisers and livestock manure, is a powerful greenhouse gas and currently the most important ozone-depleting substance emitted by human activities (Kanter, 2018). Agriculture is responsible for around two-thirds of global nitrous oxide emissions, and the gas accounts for about 6% of global greenhouse gas emissions (Kanter, 2018). Ammonia also affects the climate by contributing to the formation of atmospheric particles that influence how heat and sunlight interact with the atmosphere (Kanter, 2018). Better nitrogen management could avoid emissions equivalent to 5–10% of the remaining global carbon budget needed to keep warming below 2°C, while also improving air quality, protecting ecosystems, and reducing water pollution (Kanter, 2018). These impacts illustrate how nitrogen emissions from agricultural systems propagate across the environment, affecting air quality, ecosystems, and the climate. As agricultural nitrogen emissions continue to rise, their environmental effects are projected to intensify unless effective mitigation measures are implemented.

Polluted river

Animal welfare and health

Ammonia emissions are closely associated with intensive livestock production systems, which also raise significant animal welfare concerns. In many industrial farming operations, animals are kept at high stocking densities in confined housing, where movement is restricted, and animals are unable to express natural behaviours (Goldberg, 2016). These systems also generate large amounts of manure, creating conditions that allow waste to accumulate in enclosed environments (Siegford et al., 2008).

These conditions not only lead to high ammonia emissions but can also expose animals to elevated concentrations of ammonia and other gases that irritate the eyes and respiratory system and contribute to stress and disease, thereby compromising their health (Goldberg, 2016).

Therefore, production systems that generate large ammonia emissions are often the same systems where animals experience poorer welfare conditions, illustrating how agricultural intensification can create shared risks across animals, ecosystems, and human populations (Siegford et al., 2008). Improving animal welfare conditions in livestock systems can therefore contribute not only to better animal treatment but also to reduced environmental pollution and improved public health outcomes.

An intensive pig farm in the UK

Human health impacts of ammonia

Why ammonia is a health-relevant pollutant

The environmental impacts of livestock waste are well recognised, including eutrophication, nitrate leaching, and odors (McCubbin et al., 2002). However, less well-known is that ammonia pollution from livestock waste may contribute to significant health problems since it is a major driver of fine particulate matter (PM_{2-5}), the air pollutant most strongly associated with disease and premature death. $PM_{2.5}$'s small size allows it to penetrate deep into the lungs and enter the bloodstream, increasing the risk of cardiovascular disease, respiratory illness, lung cancer, and early mortality (Landrigan et al., 2018). Globally, 39% of $PM_{2.5}$ is derived from ammonia (Gu et al., 2021) making ammonia one of the most important drivers of air pollution and its related health impacts (Wyer et al., 2022)

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Direct health effects

Ammonia is a respiratory irritant and can have adverse health effects at high levels of exposure (Wyer et al., 2022). In agricultural facilities, exposure to extremely high concentrations is uncommon and typically associated with farming accidents. However, occupational exposure in agricultural settings can lead to respiratory symptoms and reduced lung function. However, exposure to lower concentrations over longer periods may still adversely affect health, with reported symptoms including irritation of the eyes, nose, and throat; cough; chest tightness; shortness of breath; headaches; and nausea (Wyer et al., 2022). Occupational exposure in livestock settings is therefore considered a health risk, particularly for workers regularly exposed to elevated ammonia concentrations in enclosed housing facilities. Concentrations of ammonia in most urban and rural environments are typically too low to cause acute toxicity (Wyer et al., 2022).

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Indirect health effects

While direct exposure to agricultural ammonia can affect workers' health, its far greater public health impact arises from its role as a precursor of fine particulate matter ($PM_{2.5}$). Exposure to $PM_{2.5}$ affects populations worldwide (Nieder & Benbi, 2021). It is estimated that more than 90% of the world's population lives in areas where $PM_{2.5}$ concentrations exceed World Health Organization (WHO) guideline levels (Nieder & Benbi, 2021). In 2019, air pollution was responsible for approximately 6.7 million premature deaths worldwide, with $PM_{2.5}$ contributing to cardiovascular disease, stroke, chronic respiratory disease, and lung cancer (World Health Organization, n.d.).

Scientific evidence also shows that food production itself can be a major driver of air-pollution-related health impacts. In the United States, poor air quality linked to agriculture has been estimated to cause 17,900 premature deaths annually, 15,900 of which are associated with food production (Domingo et al., 2021). Of these deaths, around 80% are attributable to animal-based foods, both directly from livestock production and indirectly from the production of animal feed (Domingo et al., 2021).

Short-term exposure to $PM_{2.5}$ can produce respiratory symptoms, asthma, cardiac arrhythmias, and cardiovascular events (Wyer et al., 2022). Long-term exposure contributes to chronic bronchitis, reduced lung development in children, lung cancer, and premature mortality (Wyer et al., 2022). Because ammonia is a major contributor to secondary $PM_{2.5}$ formation, reducing ammonia emissions directly helps lower the burden of air-pollution-related diseases (Nieder & Benbi, 2021).

Emerging evidence suggests that the health effects of $PM_{2.5}$ extend beyond cardiovascular and respiratory disease. Long-term exposure has also been linked to non-communicable diseases, including type 2 diabetes, impaired cognitive development in children, attention-deficit and neurodevelopmental disorders, and neurodegenerative diseases such as dementia in adults (Landrigan et al., 2018). $PM_{2.5}$ exposure has also been linked to premature birth and low birthweight, and a possible association with sudden infant death syndrome (Landrigan et al., 2018). These findings indicate that the health burden of particulate air pollution, and therefore of ammonia as a key precursor, may be broader than fully recognised, and that it is not only an environmental concern but a necessary strategy for preventing several diseases and premature mortality.

> ***In 2019, air pollution was responsible for approximately 6.7 million premature deaths worldwide.***

Vulnerable and most affected populations

Scientific evidence shows that certain population groups are more susceptible to the effects of particulate air pollution, including older adults, children, pregnant women, people with pre-existing cardiovascular or respiratory disease, and lower-income communities (Peled, 2011).

Children are more vulnerable because their lungs and immune systems are still developing, and they breathe in more air per unit of body weight than adults (Peled, 2011). Also, older people are more vulnerable to pollution-related respiratory and cardiovascular problems due to age-related physiological changes and pre-existing conditions (Peled, 2011). People with pre-existing diseases are especially sensitive to fine particulate matter pollution, because it can exacerbate symptoms, increase the risk of hospitalisation, and contribute to higher mortality (Peled, 2011).

Communities living near intensive livestock operations may face higher exposure to ammonia and secondary particulate pollution, exacerbating existing rural health inequalities (Wyer et al., 2022). In addition, socioeconomically disadvantaged communities often face higher exposure to environmental pollution and have fewer resources to mitigate health risks (Landrigan et al., 2018). Therefore, vulnerable and marginalised groups around the world are particularly impacted by air pollution-related diseases.

Ammonia in the UK: Emissions, sources and exposure

In the UK, agriculture was responsible for 89% of the total ammonia (NH_3) emissions in 2024, predominantly from farmed animals (UK Government, 2026). Figure 1 shows the ammonia emissions from the UK in the years 2024, 2023, 2005 and 1990. As the figure shows, the total ammonia emissions have reduced from 1990 levels.

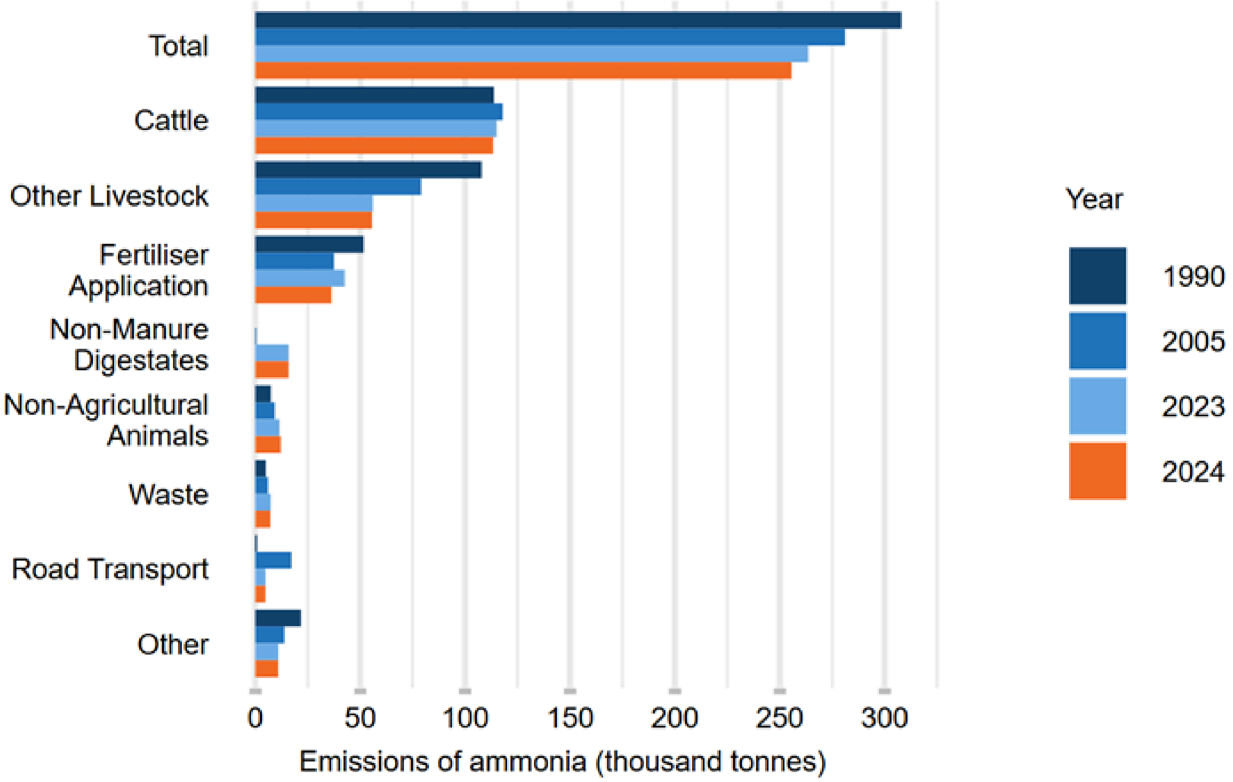


***Figure 1:** Ammonia emissions in the UK from 2024 (orange), 2023 (light blue), 2005 (blue) and 1990 (dark blue) taken from UK Government 2026.*

Caswell et al., (2024) conducted an inventory of ammonia emissions from agriculture in the UK in 2023 (Table 1) (UK Government, 2026). They found that the largest contributor of NH_3 emissions in the UK was from cattle (combined dairy, beef and non-lactating dairy) with 113.2 Kt NH_3. Their research also showed that across management categories (including grazing, hard standings, manure storage and application), housing accounted for the highest levels of NH3 emitted overall in 2023 (57.6 Kt NH_3) compared to grazing which was significantly lower with 18.5 Kt NH_3 (UK Government, 2026).

Differences within housing systems for livestock have been shown to impact NH_3 emissions. CAFOs raise animals in confinement at higher stocking densities (Ilea & Ilea, 2008), which usually involves indoor conditions to maximise production per unit of land. These installations can vary in design and manure removal practices, however there is mixed evidence surrounding emissions from floor type and housing design. There is some evidence to suggest that the use of bedding, such as straw or sawdust, in deep litter systems presents lower NH_3 emissions when compared to a fully slatted floor design (Wang et al., 2011). The addition of 33% extra straw was found to reduce NH_3 emissions from cattle by 50%, whilst the addition of 100% more straw reduced emissions from pigs (Gilhespy et al., 2009). This effect can be due to the bedding's absorbent nature, which enables the capture of readily available N, allowing the microbial population to start the immobilising process (Nahm, 2003).

Reduced emissions from animals in grazed conditions could be a result of the total ammoniacal nitrogen (TAN) in urine being excreted directly on pastures and absorbed by the soil (EEA, 2019). Pakro and Dillon (1995) report that 24% of urinary nitrogen (N) in non-irrigated soil leached below a depth of 150mm, with the remaining urinary-N converting from urea to ammonium within a day (Pakro & Dillon, 1995). This naturally occurring process thus reduces the potential of urea volatilising to ammonia. Several variables impact NH_3 excreted and volatilised on soil, including N intake, air velocity, and temperature (Edouard et al., 2016). Fluxes in NH_3 can also depend on plant growth rate, impacting the availability of NH4+ in the soil (Jarvis & Ledgard, 2002). Thus, additional factors should also be considered when observing differences in NH_3 emissions in varying conditions. A study comparing the management of dairy cattle in New Zealand and the UK found that the requirement for winter housing in the UK and the associated collection, storage, and application of their excreta contributed two times greater NH_3 losses (per livestock unit) than the New Zealand farm, where cattle grazed 365 days a year (Jarvis & Ledgard, 2002).

Pigs on a slatted floor in a UK pig farm

Table 1: *Ammonia emission estimates for UK agriculture in 2023 (taken from Carswell et al., 2024).*

Source	**Kt NH3**	**% of total**
Farmed animals		**733**
Cattle (total)	1.132	490
Dairy cows	569	246
Cattle	563	244
Sheep	117	51
Pigs	148	64
Poultry	282	122
Other	12	5
Management		**733**
Grazing/ outdoors	185	80
Housing	576	250
Hard standings	139	60
Manure storage	192	83
Manure application to soil	554	240
Manure digestate storage	4	2
Manure digestate soil	41	18
Other		**267**
Fertilizer (total)	410	178
Urea and UAN	302	131
Ammonium nitrate, calcium ammonium nitrate, ammonium sulphate, diammonium phosphate and other nitrogen fertilisers	108	47
Sewage sludge	48	21
Non-manure digestate	158	69
TOTAL	**2.307**	

Other major sources of ammonia in farming include manure slurry in livestock houses (Groenestein, 2006), storage of slurry (Hellsten et al., 2007) and manure application (Sommer & Hutchings, 2001). These outcomes are widely found as a result of intensive farming methods, in which large numbers of animals are typically kept indoors and at high densities (Douglas et al., 2018).

Manure livestock houses

With the intensification of agricultural production larger outputs of animal waste are required to be managed and disposed of. Animal waste usually consists of solid manure, mainly composed of faeces and straw and slurry manure, which with the addition of washing water contains lower dry matter content and little use of bedding materials (Sommer & Hutchings, 2001). Due to its nature solid manure can be gathered in a stack or heap which may provide favourable conditions for composting and aerobic decomposition (Rotz, 2004). This can subsequently lead to a reduction in total ammoniacal N of applied, influencing NH_3 volatilisation rate.

Research surveyed on dairy farms found that the composition of manure was significantly correlated with farm size, with larger farms (200+ animal units) handling more liquid manure with longer term storage, whilst the small farms (1-99 AU) managed largely solid manure with daily application to land. Larger and permitted (>=1000 AU) facilities generated greater NH_3 emissions, of which were found to mostly occur during slurry storage (Aguirre-Villegas & Larson, 2017). Whereas a study comparing the management of dairy cattle in New Zealand and the UK found that the requirement for winter housing in the UK and the associated collection, storage and application of their excreta contributed two times greater NH_3 (per livestock unit) than the New Zealand farm, where cattle grazed 365 days a year (Jarvis & Ledgard, 2002). These results suggest that more extensive grazing systems lower NH_3.

Ammonia volatilization from manure causes direct atmospheric pollution in poultry houses which has toxic implications for workers and animals (Moore et al., 1996). Workers in industrial food animal production, who experience heightened exposure to such compounds, exhibit elevated rates of respiratory illness.

> **"*Ammonia volatilization from manure causes direct atmospheric pollution in poultry houses which has toxic implications for workers and animals.*"**

Slurry storage

Slurry is stored in varying systems such as tanks (above and below ground), open earthen pits and lagoons, of which have been shown to promote anaerobic conditions and greater emission factors of NH_3, when compared to solid manure from dairy cattle (Sommer et al., 2019). However, a <10% loss of N from lagoons can be maintained using slurry storage with a natural crust or other cover (Rotz, 2004).

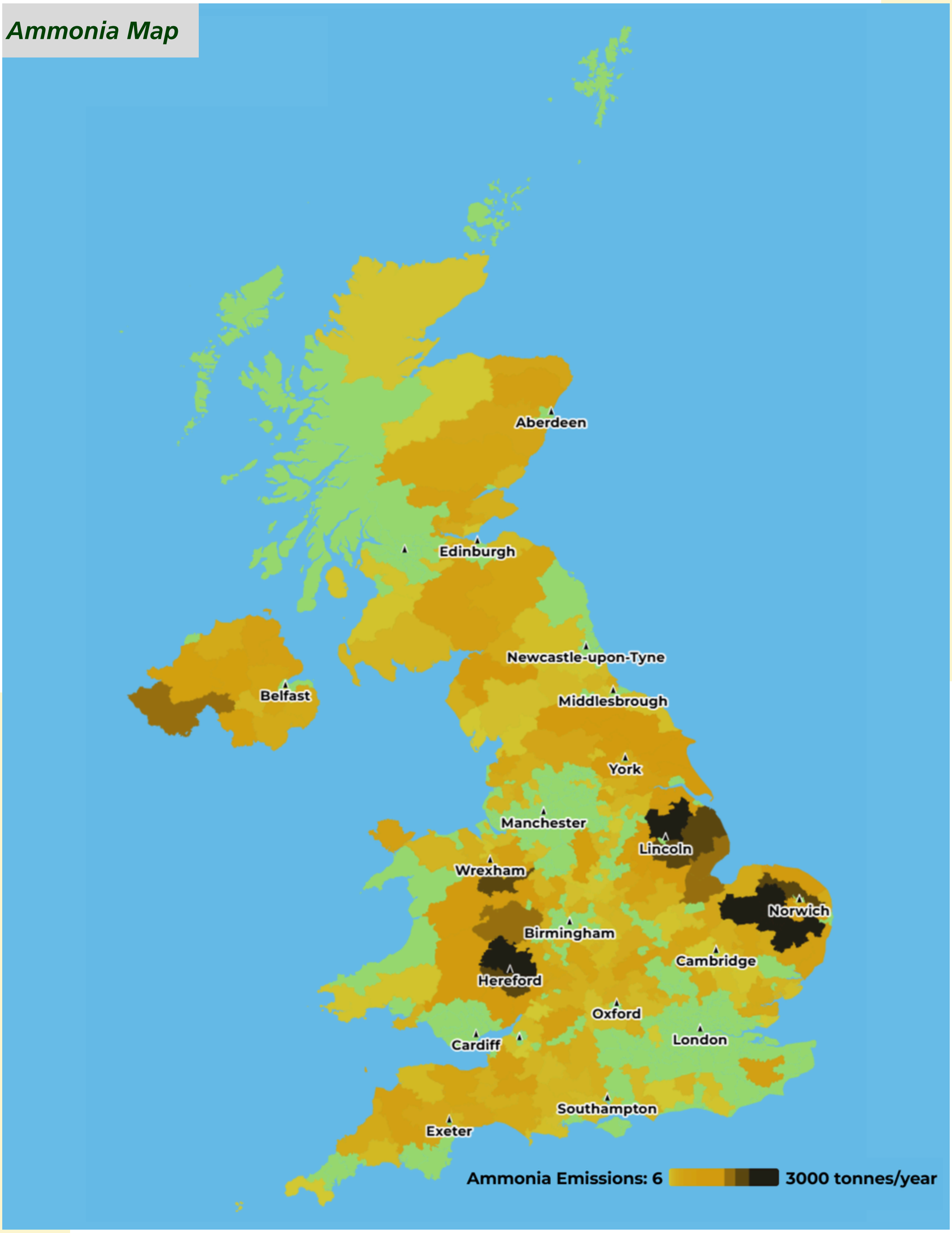
Slurry spreading

Large scale manure application is also suggested to negatively impact NH_3 emissions from animal agriculture. In intensive farming this usually involves the spreading of slurry, where N loss and NH_3 volatilisation rapidly occurs following application, with 30 to 70% of the total loss occurring within the first 6 to 12 h (Meisinger & W E Jokela, 2000).

Agricultural slurry spreading in a field in England

Compassion in World Farming's Ammonia Map shows how much ammonia pollution chicken and pig factory farms are releasing into the air. Once that ammonia is released, it is blown across the country. Whilst communities living nearest to factory farms may face higher exposure to ammonia and $PM_{2.5}$ pollution, it can reach far into towns and cities across the UK.

Visit ciwf.org.uk/AmmoniaMap to explore the interactive map.



Ammonia and air quality in the UK

The AENEID model (Atmospheric Emissions for National Environmental Impacts Determination model) was used to explore the relationship between ammonia emissions and seasonality. The authors then linked this back to both regional and national farming practices to see whether there was a connection. Variation in ammonia emissions has been related to farming activities with >50% of NH_3 emissions are from cattle. A decrease in emissions is seen over summer due to livestock grazing outside, with a small peak was seen in October related to the movement of cattle back inside and manure spreading. The emission potential from cattle is greater when they are housed as opposed to when they are kept outside. Some dairy cows are still kept housed to a degree over summer which means that in areas where there is a high proportion of dairy farms there are increased emissions over summer (as opposed to primarily beef areas) (Hellsten et al., 2007).

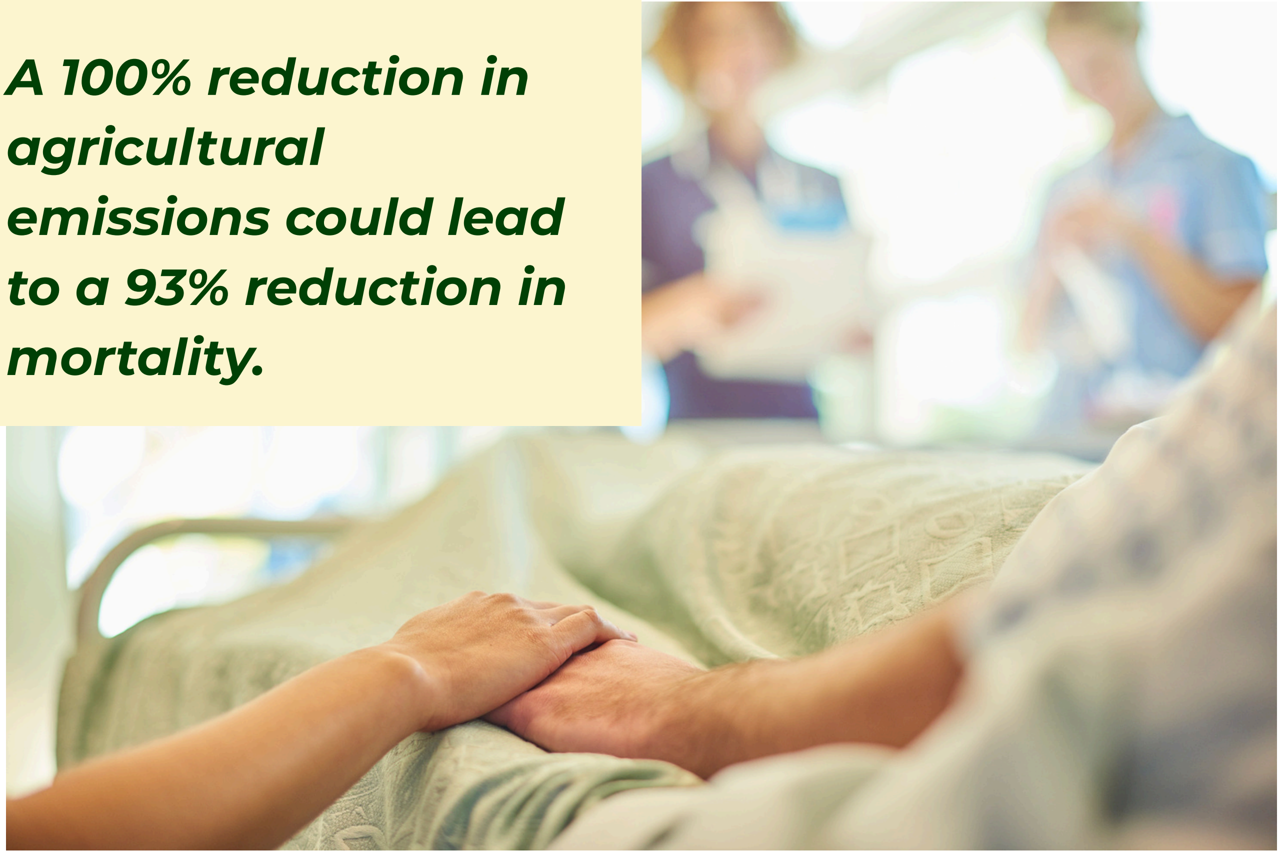
The AENEID model was also used to assess the amount of ammonia emitted from different areas of the UK. For this, the UK is split into a grid consisting of 5km x 5km squares and then look at which livestock categories are kept primarily in that area and what ‘activities’ are going on (grazing, housing, manure storage and spreading manure). High levels of ammonia emissions have been noted in areas with intensive livestock farming with the highest levels are seen as a result of intensive pig and poultry farming and medium to high emissions are seen from dairy farming. Low livestock emissions only occur in 37% of the grids evaluated. Agricultural emissions are dominant (i.e. contribute >50% of the emissions) in 82% of the grids. Pigs and poultry create ‘hotspots’ due to the area of intensive farming being very localized (Hellsten et al., 2008).

> ***High levels of ammonia emissions have been noted in areas with intensive livestock farming.***

The ammonia health burden in the UK

Giannadaki et al., (2018) provided a cost benefit analysis of different methods of reducing emissions (Giannadaki et al., 2018). In 2010, the UK has an estimated 15,470 deaths attributed to $PM_{2.5}$. Using modelling, it was shown that a 50% reduction in agriculture emissions could lead to a 21% reduction in mortality, 75% reduction could lead to a 47% reduction in mortality and 100% reduction in agricultural emissions could lead to a 93% reduction in mortality from $PM_{2.5}$. Kelly et al., (2023) assessed the main contributors of particulate matter pollution within UK cities (focusing on Leicester, Birmingham and London) (Kelly et al., 2023). The results showed that 79% of the UK areas simulated exceeded WHO guidelines for $PM_{2.5}$ (should be <5 μg m– 3) resulting in '29,000–99,000 premature adult deaths each year' may be a result of $PM_{2.5}$ exposure. Further, the paper shows that - national agriculture contributes 32% UK mean total $PM_{2.5}$, 25-39% of pollution by $PM_{2.5}$ in urban areasis from agricultural sources and 86% of total NH_3 comes from agriculture.

> ***A 100% reduction in agricultural emissions could lead to a 93% reduction in mortality.***



Ammonia policy and legislation in the UK

The UK under the Gothenburg Protocol and National Emission Ceilings Regulation (NECR) (2018) has set legally binding targets to reduce ammonia emissions by 8% below 2005 levels by 2020 and then in each year up to 2029. Additionally, the NECR stipulates that the UK must reduce ammonia pollution by 16% below 2005 levels by 2030 (UK Government, 2026. In 2024, ammonia emissions in the UK fell to 9% meeting their legally binding targets. The main influence on ammonia emissions is agriculture. Emissions from agriculture were responsible for 89% of the total ammonia emissions in the UK in 2024 (UK Government, 2026. Despite these ammonia targets, the UK government implements an adjustment mechanism to subtract emissions from non-manure digestate – this is to ensure that the ammonia emissions remain within the target. As 2024 remained within target (9% since 2005) no adjustment was needed – however, this adjustment mechanism was used in 2020 to 2023 to ensure that the UK Government was compliant (UK Government, 2026). Non-manure digestate is produced through anerobic digestion of organic materials providing a nutrient rich material – this does not include animal waste and are instead produced by food waste, energy crops and crop residues (UK Government, 2026).

Unintended consequences of ammonia reduction on farm

Acid air scrubbers

There are several mitigation methods to reduce ammonia – one of the most efficient methods is acid air scrubbers for pigs and poultry with up to 80% ammonia emission reduction efficiency (Bittman et al., 2014). However, to operate acid air scrubbing – it locks farmed animals in factory farming systems. Other management practices also include partially slatted floors (30% ammonia emission reduction efficiency). These management systems compromise the welfare of farmed animals.

Anerobic digesters

Anerobic digesters can be used to convert slurry, manure and litter into biogas or biofertilizer (digestate). Through the production of both energy and fertilizer these technologies are considered as part of the circular economy.

> ***The UK must reduce ammonia pollution by 16% below 2005 levels by 2030.***

References

Aguirre-Villegas, H. A., & Larson, R. A. (2017). Evaluating greenhouse gas emissions from dairy manure management practices using survey data and lifecycle tools. Journal of Cleaner Production, 143(6), 169–179. https://doi.org/10.1016/j.jclepro.2016.12.133

Bauer, S. E., Tsigaridis, K., & Miller, R. (2016). Significant atmospheric aerosol pollution caused by world food cultivation. Geophysical Research Letters, 43(10), 5394–5400. https://doi.org/10.1002/2016GL068354

Behera, S. N., Sharma, M., Aneja, V. P., & Balasubramanian, R. (2013). Ammonia in the atmosphere: A review on emission sources, atmospheric chemistry and deposition on terrestrial bodies. Environmental Science and Pollution Research, 20(11), 8092–8131. https://doi.org/10.1007/s11356-013-2051-9

Bittman, S. ., Dedina, M. ., Howard, C. M. (Clare)., Oenema, O. ., & Sutton, M. A. . (2014). Options for ammonia mitigation : guidance from the UNECE Task Force on Reactive Nitrogen. Centre for Ecology & Hydrology, on behalf of Task Force on Reactive Nitrogen, of the UNECE Convention on Long Range transboundary Air Pollution.

Domingo, N. G. G., Balasubramanian, S., Thakrar, S. K., Clark, M. A., Adams, P. J., Marshall, J. D., Muller, N. Z., Pandis, S. N., Polasky, S., Robinson, A. L., Tessum, C. W., Tilman, D., Tschofen, P., & Hill, J. D. (2021). Air quality-related health damages of food. Proceedings of the National Academy of Sciences of the United States of America, 118(20). https://doi.org/10.1073/pnas.2013637118

Douglas, P., Robertson, S., Gay, R., Hansell, A. L., & Gant, T. W. (2018). A systematic review of the public health risks of bioaerosols from intensive farming. International Journal of Hygiene and Environmental Health, 221(2), 134–173. https://doi.org/10.1016/j.ijheh.2017.10.019

Edouard, N., Hassouna, M., Robin, P., & Faverdin, P. (2016). Low degradable protein supply to increase nitrogen efficiency in lactating dairy cows and reduce environmental impacts at barn level. Animal, 10(2), 212–220. https://doi.org/10.1017/S1751731115002050

EMEP/EEA air pollutant emission inventory guidebook 2019 | Publications | European Environment Agency (EEA). (n.d.). Retrieved March 9, 2026, from https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2019

Emissions of air pollutants in the UK – Ammonia (NH3) - GOV.UK. (n.d.). Retrieved March 9, 2026, from https://www.gov.uk/government/statistics/emissions-of-air-pollutants/emissions-of-air-pollutants-in-the-uk-ammonia-nh3

Giannadaki, D., Giannakis, E., Pozzer, A., & Lelieveld, J. (2018). Estimating health and economic benefits of reductions in air pollution from agriculture. Science of The Total Environment, 622–623(10), 1304–1316. https://doi.org/10.1016/j.scitotenv.2017.12.064

Gilhespy, S. L., Webb, J., Chadwick, D. R., Misselbrook, T. H., Kay, R., Camp, V., Retter, A. L., & Bason, A. (2009). Will additional straw bedding in buildings housing cattle and pigs reduce ammonia emissions? Biosystems Engineering, 102(2), 180–189. https://doi.org/10.1016/j.biosystemseng.2008.10.005

Goldberg, A. M. (2016). Farm Animal Welfare and Human Health. Current Environmental Health Reports, 3(3), 313–321. https://doi.org/10.1007/s40572-016-0097-9

Groenestein, C. M. (2006). Environmental aspects of improving sow welfare with group housing and straw bedding.

Gu, B., Zhang, L., Dingenen, R. Van, Vieno, M., Grinsven, H. J. Van, Zhang, X., Zhang, S., Chen, Y., Wang, S., Ren, C., Rao, S., Holland, M., Winiwarter, W., Chen, D., Xu, J., & Sutton, M. A. (2021). Abating ammonia is more cost-effective than nitrogen oxides for mitigating $PM_{2.5}$ air pollution. Science, 374(6568), 758–762. https://doi.org/10.1126/science.abf8623

Hellsten, S., Dragosits, U., Place, C. J., Misselbrook, T. H., Tang, Y. S., & Sutton, M. A. (2007). Modelling Seasonal Dynamics from Temporal Variation in Agricultural Practices in the UK Ammonia Emission Inventory. Water, Air, & Soil Pollution: Focus 2007 7:1, 7(1), 3–13. https://doi.org/10.1007/s11267-006-9087-5

Hellsten, S., Dragosits, U., Place, C. J., Vieno, M., Dore, A. J., Misselbrook, T. H., Tang, Y. S., & Sutton, M. A. (2008). Modelling the spatial distribution of ammonia emissions in the UK. Environmental Pollution, 154(3), 370–379. https://doi.org/10.1016/j.envpol.2008.02.017

Ilea, R. C., & Ilea, R. C. (2008). Intensive Livestock Farming: Global Trends, Increased Environmental Concerns, and Ethical Solutions. Journal of Agricultural and Environmental Ethics 2008 22:2, 22(2), 153–167. https://doi.org/10.1007/s10806-008-9136-3

Jarvis, S. C., & Ledgard, S. (2002). Ammonia emissions from intensive dairying: a comparison of contrasting systems in the United Kingdom and New Zealand. Agriculture, Ecosystems & Environment, 92(1), 83–92. https://doi.org/10.1016/S0167-8809(01)00283-3

Kanter, D. R. (2018). Nitrogen pollution: a key building block for addressing climate change. Climatic Change 2018 147:1, 147(1), 11–21. https://doi.org/10.1007/s10584-017-2126-6

Kelly, J. M., Marais, E. A., Lu, G., Obszynska, J., Mace, M., White, J., & Leigh, R. J. (2023). Diagnosing domestic and transboundary sources of fine particulate matter ($PM_{2.5}$) in UK cities using GEOS-Chem. City and Environment Interactions, 18(7), 100100. https://doi.org/10.1016/j.cacint.2023.100100

Landrigan, P. J., Fuller, R., Acosta, N. J. R., Adeyi, O., Arnold, R., Basu, N. (Nil), Baldé, A. B., Bertollini, R., Bose-O'Reilly, S., Boufford, J. I., Breysse, P. N., Chiles, T., Mahidol, C., Coll-Seck, A. M., Cropper, M. L., Fobil, J., Fuster, V., Greenstone, M., Haines, A., … Zhong, M. (2018). The Lancet Commission on pollution and health. The Lancet, 391(10119), 462–512. https://doi.org/10.1016/S0140-6736(17)32345-0

Luo, L., Luo, B., & Tai, A. P. K. (2025). Reactive Nitrogen from Agriculture: A Review of Emissions, Air Quality, and Climate Impacts. Current Pollution Reports, 11(1). https://doi.org/10.1007/s40726-025-00360-y

McCubbin, D. R., Apelberg, B. J., Roe, S., & Divita, F. (2002). Livestock Ammonia Management and Particulate-Related Health Benefits. Environmental Science and Technology, 36(6), 1141–1146. https://doi.org/10.1021/es010705g

Meisinger, J. J., & W E Jokela, P. D. (2000). Ammonia Volatilization from Dairy and Poultry Manure. In Managing, Nutrients and Pathogens from Animal Agriculture. Ithaca, NY: Natural Resource, Agriculture, and Engineering Service (pp. 334–354). www.nraes.org

Moore, P. A., Daniel, T. C., Edwards, D. R., & Miller, D. M. (1996). Evaluation of Chemical Amendments to Reduce Ammonia Volatilization from Poultry Litter. Poultry Science, 75(3), 315–320. https://doi.org/10.3382/ps.0750315

Nahm, K. H. (2003). Evaluation of the nitrogen content in poultry manure. World's Poultry Science Journal, 59(1), 77–88. https://doi.org/10.1079/WPS20030004

Nieder, R., & Benbi, D. K. (2021). Reactive nitrogen compounds and their influence on human health: an overview. Reviews on Environmental Health, 37(2), 229–246. https://doi.org/10.1515/reveh-2021-0021

Pakro, N., & Dillon, P. (1995). Preferential flow, nitrogen transformations and 15N balance under urine-affected areas of irrigated and non-irrigated clover-based pastures. Journal of Contaminant Hydrology, 20(3–4), 329–347. https://doi.org/10.1016/0169-7722(95)00077-1

Peled, R. (2011). Air pollution exposure: Who is at high risk? Atmospheric Environment, 45(10), 1781–1785. https://doi.org/10.1016/j.atmosenv.2011.01.001
Rotz, C. A. (2004). Management to reduce nitrogen losses in animal production. Journal of Animal Science, 82(suppl_13), E119–E137. https://doi.org/10.2527/2004.8213_supplE119x

Siegford, J. M., Powers, W., & Grimes-Casey, H. G. (2008). Environmental Aspects of Ethical Animal Production. Poultry Science, 87(2), 380–386. https://doi.org/10.3382/ps.2007-00351

Sommer, S. G., & Hutchings, N. J. (2001). Ammonia emission from field applied manure and its reduction—invited paper. European Journal of Agronomy, 15(1), 1–15. https://doi.org/10.1016/S1161-0301(01)00112-5

Sommer, S. G., Webb, J., & Hutchings, N. D. (2019). New Emission Factors for Calculation of Ammonia Volatilization From European Livestock Manure Management Systems. Frontiers in Sustainable Food Systems, 3, 479072. https://doi.org/10.3389/fsufs.2019.00101

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., De Vries, W., De Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223). https://doi.org/10.1126/science.1259855

Sutton, M. A., Erisman, J. W., Dentener, F., & Möller, D. (2008). Ammonia in the environment: From ancient times to the present. Environmental Pollution, 156(3), 583–604. https://doi.org/10.1016/j.envpol.2008.03.013

Wang, K., Wei, B., Zhu, S., & Ye, Z. (2011). Ammonia and odour emitted from deep litter and fully slatted floor systems for growing-finishing pigs. Biosystems Engineering, 109(3), 203–210. https://doi.org/10.1016/j.biosystemseng.2011.04.001

Winkler, A. S., Brux, C. M., Carabin, H., das Neves, C. G., Häsler, B., Zinsstag, J., Fèvre, E. M., Okello, A., Laing, G., Harrison, W. E., Pöntinen, A. K., Huber, A., Ruckert, A., Natterson-Horowitz, B., Abela, B., Aenishaenslin, C., Heymann, D. L., Rødland, E. K., Berthe, F. C. J., … Amuasi, J. H. (2025). The Lancet One Health Commission: harnessing our interconnectedness for equitable, sustainable, and healthy socioecological systems. The Lancet, 406(10502), 501–570. https://doi.org/10.1016/S0140-6736(25)00627-0

World Health Organization. (n.d.). Health consequences of air pollution. Retrieved March 3, 2026, from https://www.who.int/news/item/25-06-2024-what-are-health-consequences-of-air-pollution-on-populations

Wyer, K. E., Kelleghan, D. B., Blanes-Vidal, V., Schauberger, G., & Curran, T. P. (2022). Ammonia emissions from agriculture and their contribution to fine particulate matter: A review of implications for human health. Journal of Environmental Management, 323, 116285. https://doi.org/10.1016/j.jenvman.2022.116285