Reconciling farming and air quality

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European farms are essential in providing quality food that can sustain life on this planet today and in the future. However, agricultural activities also impact the environment. For example, agriculture is responsible for 92% of the ammonia emissions that impact air quality in Europe and 17% of these emissions are derived from the use of nitrogen fertilizers.

Ammonia emissions have an impact on both human health (contribution to the formation of particle matter in the atmosphere) and on the environment (acid deposition and eutrophication). It is only since the late 1970s that cleaner air has been one of the key environmental policy priorities in Europe. The European Commission has recently published the 'First Clean Air Outlook' which identifies the efforts needed in the run up to 2030 to solve challenges such as the ammonia emissions from agriculture.

There is mounting pressure on the farming to deliver on these environmental challenges. The fertilizer industry strives to support farmers to address these obstacles by providing them with better products and know-how that can support them in improving air quality while remaining economically viable.

> *"Agriculture is responsible for 92% of volatile ammonia emissions*

Solutions are already available. Good fertilization practices can help farmers make optimal decisions to improve resource efficiency and consequently reduce ammonia emissions.

The impacts of agriculture and mineral fertilizers on air quality

Agriculture is responsible for 92% of volatile ammonia emissions (NH_3). The major contributor is livestock and manures both management and application (64%) followed by the use of nitrogen fertilizers (17%). The remaining 19% of ammonia emissions are caused by other sources (see figure 1).

Farmers use nitrogen fertilizers to achieve high quality yields without mining soils reserves (so that the soil fertility is maintained). The nitrogen, which is present in all kinds of fertilizers including manure, ammonium nitrate based and urea based fertilizers, undergoes chemical processes in the soil to be transformed into nitrates that can be absorbed by the crops. Some of these processes emit ammonia into the atmosphere. However, the amount of ammonia emitted into the atmosphere is not the same for all types of fertilizers and it depends on many factors including application method, type of fertilizer used, soil and weather conditions.

All mineral nitrogen fertilizers have to be transformed into nitrate (NO_3-) before they can be taken up by plants. Ammonium (NH_4+) is an intermediate compound which is either directly applied (as ammonium nitrate NH_4NO_3) or converted in the soil from urea ($CO(NH_2)_2$).

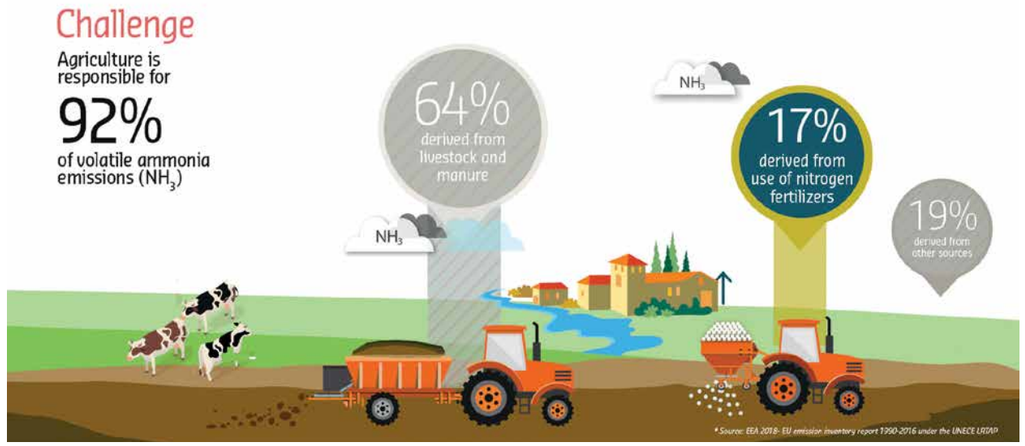

Figure 1. Agriculture emission challenges

Ammonium is in equilibrium with ammonia (NH_3) in the soil solution. The higher the pH, the more the balance shifts in favour of ammonia. UAN is a mix of AN and urea and thus activates all the pathways (see figure 2). Urea and ammonium-based fertilizers are therefore subject to potential ammonia losses. However, urea is specifically prone to ammonia volatilization. Ammonia emissions from urea-based fertilizers are consequently 63% higher than emissions from Calcium Ammonium Nitrate (CAN) fertilizers.

Soil and weather conditions

The higher the soil pH level, the more ammonium is converted to ammonia. The weather conditions also influence ammonia volatilization. More specifically, the higher the temperature, the more ammonia is

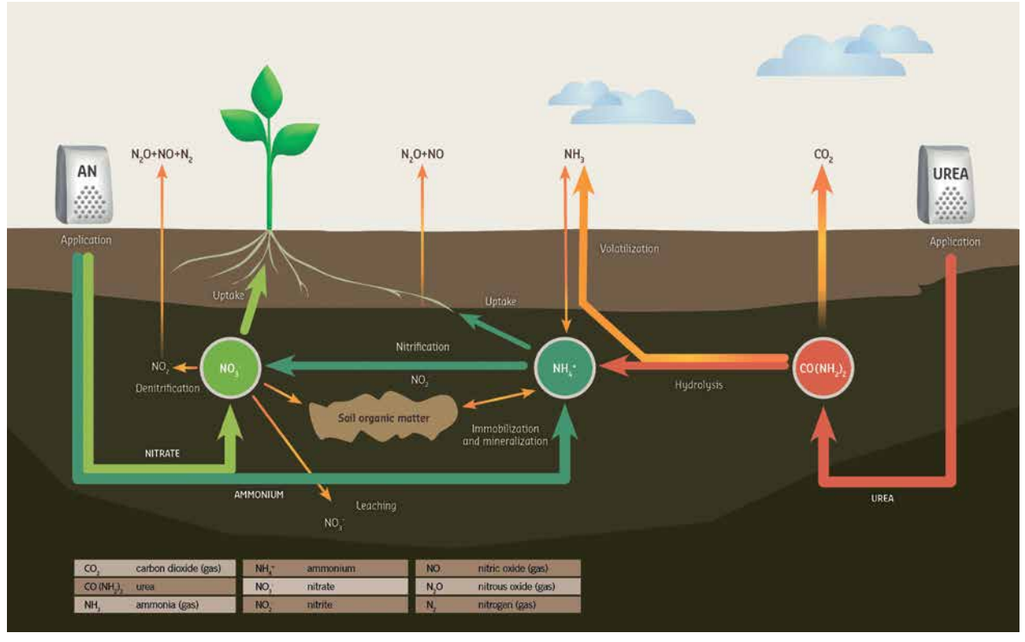

Figure 2. Different mineral fertilizers have different impacts on the air we breathe; *Source: Yara*

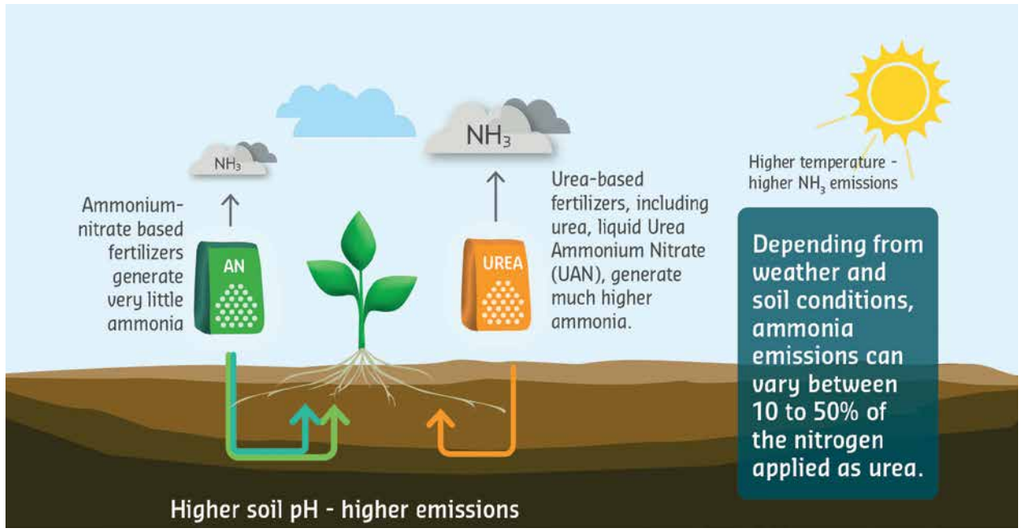

Figure 3. Ammonia emissions from fertilizer application depend on the type of fertilizer used as wells as weather and soil conditions

lost to the atmosphere. Depending on the soil and weather conditions, the volatilization loss may vary from around 10% up to 50% of the nitrogen applied as urea.

Reconciling food production and ammonia emission control

All farmers want to get better performances from the inputs they buy and that certainly applies to nitrogen fertilizer. Nitrogen lost in the atmosphere is nitrogen which is not taken up by crops, resulting in loss of money for farmers. The overall objective of farming is to optimize nitrogen inputs in order to maximize the yield (increasing nitrogen use efficiency) and consequently minimize losses to the environment (including ammonia emissions).

How to improve the situation

There are already several, well-known good agricultural practices for optimal use of mineral fertilizers, which European farmers can implement to minimize ammonia losses:

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Choice of fertilizer type

The form of nitrogen used is very important. Calcium ammonium nitrate and ammonium ensure the lowest emissions. Thus, it is crucial to not look only at the price of mineral fertilizers, but also at the agronomic and environmental characteristics.

Urea use

Depending on the site-specific farm conditions, urea might remain a viable option. In this case it is important to follow a series of good practices:

a) Immediate incorporation - Incorporation of urea into the soil immediately upon spreading, either by closed-slot injection or by cultivation, reduces potential volatilization losses by up to 70%. However, also in this case, ammonia emissions still remain more than three times higher than those from CAN/AN.

b) Consider weather conditions - Spreading urea under hot and windy conditions with no rainfall expected upon spreading should be avoided. Instead, humid soils improve diffusion, while cool weather conditions (<15°C) curb the formation of ammonia in the soil and subsequent volatilization losses from urea.

c) Consider soil conditions - Soils with a high pH levels result in higher volatilization losses. Urea and UAN therefore should not be spread on such soils.

d) Split application - Spreading mineral fertilizers in two or three applications during the crop cycle instead of once at the beginning of the growing season allows for better uptake by the plant and therefore reduces potential losses caused by higher ammonia concentrations and volatilizations risks.

e) Inhibitors - For site-specific farm conditions, urea containing inhibitors might remain a good option. An inhibitor is an agronomic additive applied to a nitrogen-based fertilizer to reduce losses once the fertilizer has been applied to the crop. Urea inhibitors can improve nitrogen use efficiency and reduce environmental impacts of urea. By extending the time the active nitrogen component of the fertilizer remains in the soil, an inhibitor reduces ammonia losses on average by 70-80%.

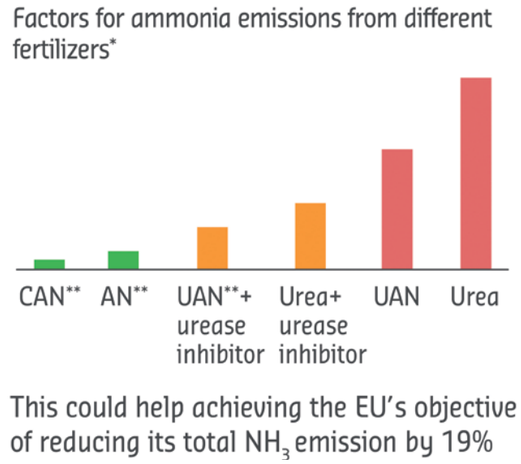
Precision fertilization for cleaner air

Precision farming contributes to enhanced uptake of nitrogen by the plants and thus reduces losses of ammonia into the air. According to the agricultural outlook of the European Commission (December 2017) ammonia emissions linked to agriculture in Europe are expected to decline by 10% until 2030 (base year 2008) thanks to the growing development and use of new technologies.

The European fertilizer industry has been working actively in the development of new tools to facilitate the fertilization decision of farmers such as planning instruments, soil analysis, decision-support instruments (testers or apps), variable rate application via GPS or sensors. The advantage of those techniques and tools is that they work for both the environment and the economics of the farm. Combined with precision nutrition, the application of nitrate-based fertilizers, such as ammonium nitrate, CAN or NPKs, makes it even more efficient.

The current revision of the Common Agriculture Policy (CAP) is a unique opportunity to raise awareness about products and practices to reduce ammonia emissions. As part of the new CAP, a new tool has been proposed that will support farmers in the use nutrients, helping them to reach better yields.

Caption: Figure 4. Importance of the form of nitrogen



Synergies for a better environment

Applying the aforementioned good agricultural practices can not only help curb ammonia emissions, but can also deliver additional environmental benefits.

Protecting the natural ecosystems - Precision fertilization, as far as the use of mineral fertilizers is concerned, together with strong advisory services provided to farmers, can contribute to ensuring high yields on limited areas. As a consequence, more space can be dedicated to boost biodiversity and in turn decrease the eutrophication of water courses.

Enhancing Nitrogen Use Efficiency (NUE) to curb ammonia - The improved fertilizer and crop management practices and tools made available to farmers by the European fertilizer industry have helped to increase NUE and reduce ammonia emissions. According to the EU Nitrogen Expert Panel in 2015, NUE can be calculated via the ratio between the amount of fertilizer nitrogen removed with the crop and the amount of fertilizer nitrogen applied. This NUE indicator provides information about the relative utilization of additional N applied to an agricultural production system of a country or region. Thus a higher NUE implies a higher N uptake and a lower N surplus (sum of N losses to air and water).

Mitigating climate change - Indirect nitrous oxide (N_2O) emissions occur following ammonia deposition. Hence ammonia reduction methods may curb nitrous oxide emissions. By managing nutrients efficiently, especially from organic fertilizers, farmers can better adapt to climate change, sequester more carbon in the soils and reduce the emissions of greenhouse gases such as N_2O emission intensity.

Maintaining viability

Farming and environmental protection can be reconciled. By applying a series of good practices, a workable balance can be achieved to ensure improvements of air quality in Europe while maintaining the viability of farming. ■

Footnote: For more information on NUE, visit the EU Nitrogen Expert Panel websit: www.eunep.com