INTERNATIONAL FERTILIZER ASSOCIATION

AGENDA 2030
Helping to Transform our World

Plant Nutrients and Clean Water

6 CLEAN WATER AND SANITATION

The fertilizer industry is dedicated to supporting and implementing Target 6.3 of the Sustainable Development Goals (SDGs): “*By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.*”

Fertilizers play a crucial role for improving crop yields and feeding the world but some of these nutrients can make their way into ground and surface water. The industry is working hard to safeguard water quality both during the production and application of fertilizers.

Key Messages:

- Eutrophication, the accumulation of nutrients in aquatic and terrestrial ecosystems that can lead to algal blooms and oxygen deficiency in water bodies, has been identified as a significant source of water pollution.
- Although eutrophication can be triggered by natural causes, plant nutrients from man-made activities, including industrial and urban wastewater, the erosion of agricultural soils and agricultural run-off also make their way into waters. Other factors such as rising water temperatures due to climate change increase the chance of eutrophication.
- Plant nutrients, in mineral and organic fertilizers applied by farmers to their fields, are vital for increasing agricultural yields, but some of these nutrients can enter into ground and surface water through leaching, runoff or soil erosion.
- To reduce eutrophication, it is important to control pollution from “point sources”, such as industrial and urban wastewater treatment sites, and reduce nutrient losses from diffuse “non-point sources” within watersheds, such as farming.
- The fertilizer industry is aware of the role of fertilizers in nutrient losses to water (and more broadly to the environment) and is actively engaged in reducing such losses in partnership with farmers, their advisors and other relevant stakeholders. Nutrient losses can be minimized when best practices in farm and, more specifically, soil, water and nutrient management are applied.

Nutrient Losses to Surface and Groundwater

Eutrophication and Hypoxia

Eutrophication, the accumulation of nutrients in water bodies that leads to an excess of algae, phytoplankton and water hyacinth, and hypoxia, the resulting oxygen depletion that can occur when they decompose, have recently been identified as leading dangers to the health of aquatic ecosystems and related ecological services. They represent a significant environmental challenge for governments, businesses, farmers and NGOs worldwide.

Eutrophication is caused by the explosive growth of macro and micro algae that feed on nutrients such as nitrates and phosphates. It can lead to algal blooms, the loss of subaquatic vegetation, changes in species composition, and the deterioration of water quality. At its most severe it can lead to hypoxia, a lack of oxygen in water due to the decomposition of biomass which may result in the death of fish and other organisms and affect biodiversity.

Eutrophication can occur naturally without human interference over long periods of time in water bodies that become filled with sediment, particularly in areas with high soil erosion, or in some cases in water bodies that are near naturally nutrient-rich soils. Climate change is another contributing factor. As water temperatures rise, the conditions become more favourable for algae to grow, especially in shallow and coastal waters.

Nutrients in Groundwater

Nitrates enter groundwater through leaching from rainfall and through irrigation. Nitrates are particularly prone to leaching as they are both soluble and mobile. The concentration of nitrates in groundwater is linked to surpluses of nitrogen at the soil surface and water management. In addition, the sandier the soil, the greater the chance of nitrates leaching.

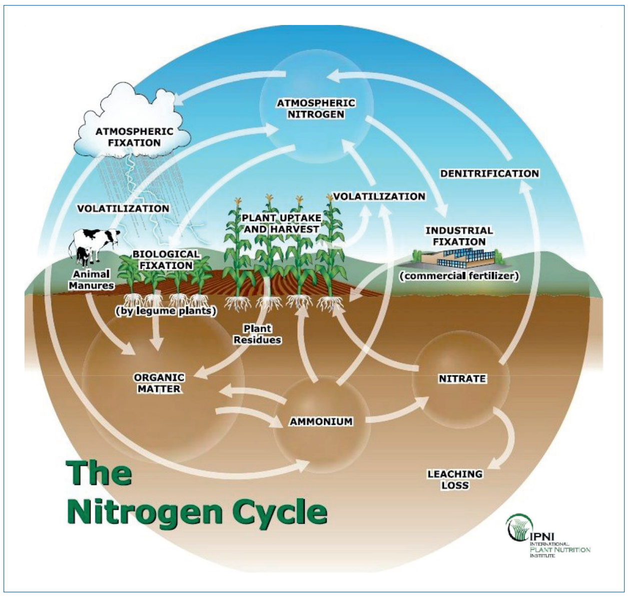
Although porous rocks in the aquifer often filter a lot of impurities from groundwater, some substances, including nitrates, are not removed in this way.

Because phosphates are not as soluble as nitrates, they tend to get adsorbed onto soil particles and enter water bodies mostly through soil erosion. Excessive phosphates in the soil or from man-made sources can also leach into groundwater but, proportionally, in smaller quantities compared to erosion and run-off losses.

The depth of water tables and the nature of the layers between the topsoil and water tables influence the time needed for nutrients to reach groundwaters. This can range from a few months for shallow water tables under sandy conditions to decades for deep ones. Therefore, the impact of changes in management practices are observed with a lag effect which is proportional to the time it takes the nutrients to travel from the soil surface to the aquifers.

Nutrient Loss Pathways

Eutrophication is caused by a surplus of N (Nitrogen) and P (Phosphorus) in water. These two nutrients are found in industrial and urban wastewater, as well as in mineral and organic fertilizers such as manure.

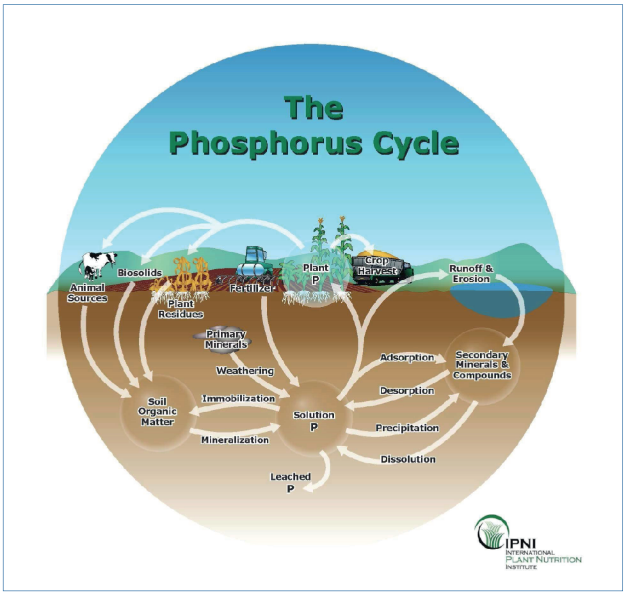


N and P cycles are complex, biological cycles. They are by definition "leaky" systems, largely due to microbial activity. They are also subject to weather conditions. As such, some N and P losses to the environment in various forms are inevitable.

Soils are natural systems that are constantly subjected to changes due to the combined effects of the environment (i.e. rainfall, weathering, etc.), plant growth and management practices. As such, it is impossible to totally eliminate N and P losses from soil.

During its cycle, N can be lost to the atmosphere as a gas, or reach ground and surface waters by leaching, runoff, soil erosion or atmospheric deposition. Specific to N, the nutrient can cascade through different reactive forms (e.g. nitrate, ammonium, ammonia, nitrous oxide, nitrogen oxides and organic matter) before returning back to the atmosphere as inert dinitrogen.

The P cycle is less complex, since P is not lost to the atmosphere. However, interactions between P and soils are complex. Water moving across the surface or through soils can remove both soluble (dissolved) and particulate (eroded soil particles) P, increasing its concentration in ground and surface waters. Most P losses occur through soil erosion and runoff.



Nutrient Sources

Nutrients make their way into waterbodies from many different sources. Clearly identifiable nutrient sources such as industrial and urban wastewater pipes are called **point sources**. **Non-point sources** are diffuse sources within a watershed.

Point sources are the easiest to measure, control and regulate. Non-point sources present more of a challenge. With numerous different sources in diverse locations occurring irregularly within a watershed, it is extremely difficult to accurately identify, measure and quantify their contributions.

Here are a few different notable non-point nutrient sources:

- Organic and mineral fertilizers and soil erosion from crop production
- Liquid manure, slurry and wastewater from livestock production
- Feed and waste from aquaculture
- Septic household waste systems
- Storm wastewater runoff from urban areas
- Atmospheric deposition of nitrogen oxides from fossil fuel combustion

Many of these non-point sources produce significant amounts of nutrients. Aquaculture produces between 42 and 66 kg of N waste and between 7.2 and 10.5 kg of P waste for every ton of fish grown; septic household waste systems leach an average of 14 kg of N per system per year; and atmospheric deposition accounts for one third of all nitrates in the Chesapeake Bay. (Strain and Hargrave 2005, Ann Arundel County Maryland DPW 2008, EPA)

Nutrients from Livestock

Livestock production is a major and increasing non-point source. Accounting for 70 percent of all agricultural land, livestock production is growing and intensifying faster than crop production in nearly all countries and is one of the top three contributors to water-quality degradation at every scale from local to global (FAO, 2006).

With some of the highest biological oxygen demand (BOD)[1], livestock wastes are a particularly large contributor to eutrophication. Pig slurry BOD, for example, is around 30-80 grams per liter, compared with the typical domestic sewage BOD of 200–500 milligrams per liter (FAO, 2006).

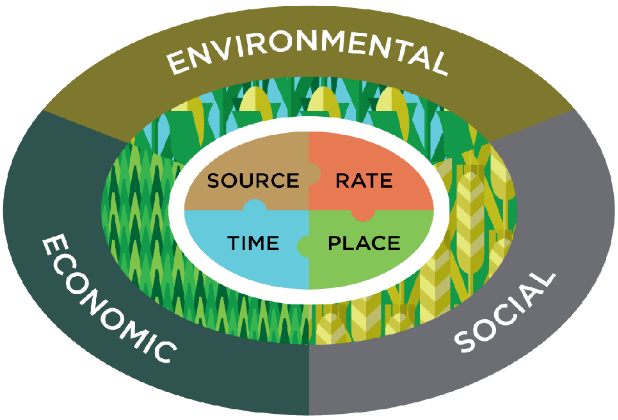
[1] Biological Oxygen Demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at a certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20 °C.

New nutrient sources are also being discovered. A recent study, for example, has found that erosion from bedrock could contribute up to 26 percent of the N in our ecosystems (Houlton et al 2018).

In order for governments and local authorities to develop effective responses it is important that the contributions of all nutrients sources are quantified globally. In many parts of the world efforts are underway to do so and various measures for both point and non-point nutrients sources are already in place.

Industry Response

The industry is aware of the role fertilizers play in nutrient losses to water and is taking a proactive part to reduce those losses through nutrient stewardship and sustainable agricultural practices.



Fertilizer Best Management Practices (BMPs)

To develop and communicate fertilizer BMPs adapted to site- and crop-specific conditions, the fertilizer industry has established an inclusive, science-based framework called **4R Nutrient Stewardship**. The 4Rs involve *applying the Right nutrients source, at the Right rate, at the Right time, in the Right place*. They can be used by all farmers, in both the developed and developing world, to help increase their crop yields, quality and income, improve the health of their soils and protect the environment by minimizing nutrient losses.

Fertilizer BMPs are practices that have been developed through scientific research. They are checked and continuously adapted in-field to improve nutrient management performance (efficiency and effectiveness), and provide economic, social and environmental benefits to stakeholders.

Improving Agricultural Practices

In addition, farmers can also adopt a range of agricultural conservation practices that improve water or soil management (the latter reducing nutrient losses by improving water retention and minimizing soil erosion):

- growing cover crops (fast-growing plants between two crops that reduce soil erosion risks)
- continuous crop rotation
- growing perennial plants in soil erosion prone areas
- reduced- or no-tillage practices or other conservation agriculture practices
- integrated plant nutrient management (using mineral and organic fertilizer together to improve soil health)
- grass buffer strips along waterbodies
- strip cropping (dividing a field into long narrow strips growing alternate crops)

Public-Private Partnerships Are Addressing the Issue

The fertilizer industry is actively partnering with a range of international research initiatives to reduce nutrient losses to the environment.

IFA is a partner of the **Global Partnership on Nutrient Management (GPNM)**, whose purpose is to steer dialogue, produce research reports and conduct pilot projects to improve the implementation of effective nutrient management. IFA is actively supporting *Towards an International Nitrogen Management System (INMS)* - a global targeted research project running from 2016 to 2019 that seeks to integrate N in all international environmental policy dialogues while filling the gaps in scientific knowledge at both regional and global levels.

As part of IFA's partnership with the United Nations' Food and Agriculture Organization (FAO), IFA was involved in the drafting of the **FAO's 2016 Voluntary Guidelines for Sustainable Soil Management**. While the primary focus of these guidelines is to increase soil fertility and soil organic matter, other positive benefits include the prevention of excess nutrient losses from agricultural fields through soil erosion and run-off.

As a member of the **FAO's Global Soil Partnership**, IFA has helped promote soil management and health globally, supporting the establishment of the *Intergovernmental Technical Panel on Soils*, a revised *Soil Charter*, the *Global Soil Organic Carbon Map* and various soil management resources, as well as actively participating in the **International Year of Soils in 2015**.

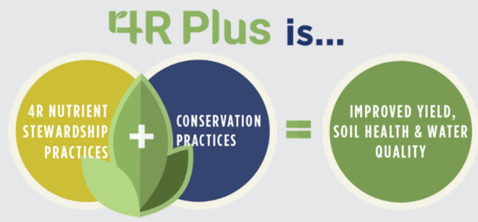
IFA also contributed to the development of the UN Global Compact's *Principles for Sustainable Soil Management* (www.unglobalcompact.org/docs/issues_doc/agriculture_and_food/soil-principles.pdf), and is actively representing the industry during the ongoing development of the **FAO's Code of Conduct for the Use and Management of Fertilizers**.

Industry Case Study: 4R Plus Iowa

The **4R Plus program** was launched in February 2018 by a group of agricultural and conservation organizations, including IFA members CF Industries and the US Fertilizer association, TFI, to help Iowa farmers protect their soils and reduce water pollution.

4R Plus combines nutrient management with conservation practices. Improving soil health starts with following the 4R nutrient stewardship practices to fully optimize nutrient use. The "Plus" refers to conservation practices that can boost production, increase soil resiliency, reduce erosion and runoff, and improve water quality.

The 4R Plus program gives farmers tools and



techniques to contribute to the Iowa Nutrient Reduction Strategy's goal to reduce N and P loads in Iowa waters by 45 percent. Conservation practices help retain moisture, soil and nutrients and reduce erosion and runoff – resulting in healthier soil and cleaner water. These practices are even more effective when targeted in areas with the greatest runoff, nutrient and soil loss.

Sustainable Water Management During Fertilizer Production

In line with SDG indicators 6.4.1: Change in water-use efficiency over time, and 6.3.1: Proportion of wastewater safely treated, fertilizer manufacturers are also working hard to monitor, evaluate and minimize their water use while maximizing its recycling and reuse during production:

- In the United States manufacturers reported they operated a total of 81 zero-discharge facilities in 2016 while the amount of water used to produce one ton of nitrogen fertilizer was reduced by 38 percent between 2013 and 2016.
- In Canada fertilizer companies that use solution mining committed to recycling up to 90 per cent of the water used in their facilities. This has contributed to a reduction of up to 15 per cent of groundwater withdrawals from 2005 to 2017.

- In India water consumption per ton of urea produced has been reduced by more than 46% over the last 25 years. For complex fertilizer plants there has been a 42% decrease during the same period.
- In Europe producers are also focused on water conservation. Between 1997 and 2015, K+S reduced their saline wastewater by nearly two thirds, while since 2013 Eurochem has reduced fresh water consumption in production by 11 million cubic meters a year, and waste water by 12.5 million cubic meters a year.
- In Africa, OCP saved 3 million cubic meters a year by switching to slurry pipelines for transporting phosphate, reduced specific water consumption by 25 percent in its new industrial processing units and has built a capacity to treat over 10 million cubic meters a year of urban wastewater for washing phosphate.
- In the Middle East producers are also focusing on their water usage, with QAFCO recycling around 5.38 million cubic meters of water in 2016, approximately 95% of their total water withdrawals.
- In Australia clean water is also a key concern for producers. To protect ecologically important wetlands by avoiding the accidental release of fertilizer nutrients, Impact Fertilisers constructed a water capture and storage system to present runoff during rainfall.

The above are just a few examples of the many ways all fertilizer manufacturers and IFA members are reducing, reusing and recycling water.

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