



PROTECTING NITROGEN FERTILIZER INVESTMENTS



Protecting nitrogen is critical for a healthy crop, yet as much as 95% of nitrogen investments are at risk of loss. And when nitrogen is lost, potential yield and profit are lost too—the biggest risk to growers. Nitrogen is one of three main nutrients needed for plant growth and development. There is no denying that nitrogen is an essential nutrient for crop production and an adequate supply is required for proper plant growth. Use this guide to learn the best ways to prevent nitrogen loss and keep your crops as healthy as possible.



The role of nitrogen

The threats to nitrogen loss

How nitrogen loss is prevented

Forms of nitrogen inputs

Protecting nitrogen above and below ground

Nitrogen management solutions

Retailer and grower opportunities

The role of nitrogen

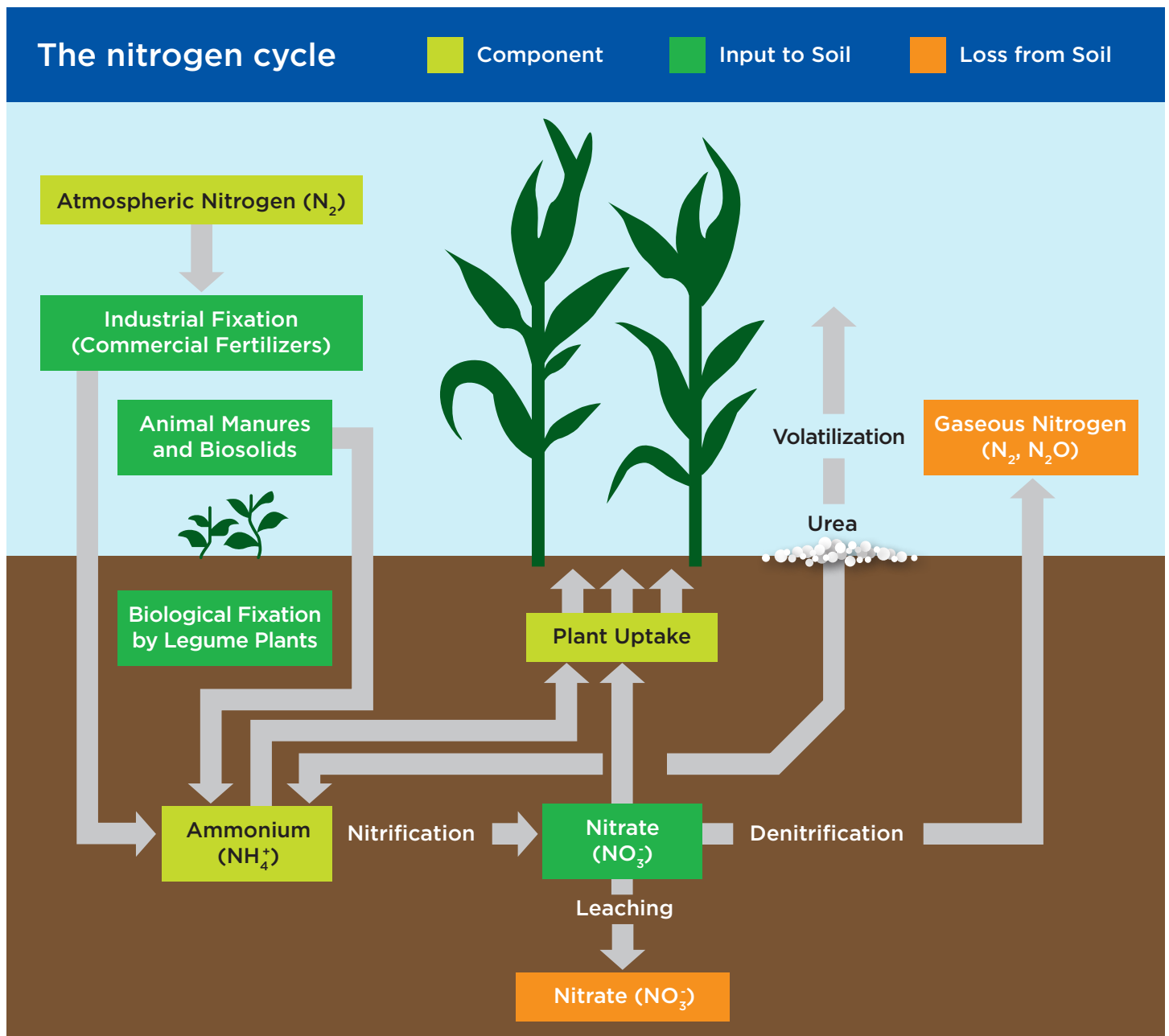
Nitrogen is critical to support corn's rapid growth and encourage the healthy development of the entire plant from roots to ears. Responsible for production of chlorophyll, nucleic acids and enzymes, nitrogen is present in various parts of a plant and affects many physiological functions. For example, nitrogen is a significant component of the amino acids in the proteins and enzymes that help roots absorb nutrients and water. It makes up a large part of the chlorophyll found in plants, which is used to make sugars that feed the plant. In addition, nitrogen impacts plant growth regulation as well as the development of proteins present in a crop's grains.

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The threats of nitrogen loss

Although nitrogen is extremely important to plant growth- it accounts for more than 57% of total fertilizer use-it is also prone to movement and breakdown in soil, leading to nitrogen loss. And what's wrong with nitrogen loss?

Nitrogen loss leads to chlorosis, or lack of chlorophyll, hindering crop growth. Corn that is grown in nitrogen deficient soil, simply put, can't make proteins, amino acids, or even its own DNA. There are 3 key ways nitrogen can be lost, volatilization, de-nitrification, and leaching. When added together, that is up to 95% of your nitrogen investment that is at risk of loss.





NBPT

DCD

30% can be lost to the atmosphere through volatilization

Volatilization is caused by nitrogen sources, such as urea, converting from organic form to ammonia gases that are then released into the atmosphere. Volatilization can account for up to 30% of nitrogen loss, and most commonly occurs in warm moist soils when the urea is on or close to the soil surface. Most nitrogen volatilization occurs in the first 7-14 days after top-dress fertilizer application if moisture is present. Volatilization is reduced when manure and urea fertilizers are applied when soil and air temperatures are cool, or when rain occurs soon after application.

5% - 35% can be lost through biological oxidation, or “de-nitrification”

Denitrification occurs when soil bacteria use nitrate for their respiration in place of oxygen in the air—converting it to nitrogen gas, therefore returning the nitrogen to the atmosphere. This process occurs more rapidly in warm, wet soil that contains an abundance of nitrates. Soil can experience nitrate loss at a rate of 5-35 percent. Denitrification can contribute to the production of greenhouse gases, reacting with the ozone layer and advancing air pollution. Avoiding overwatering, overfertilizing and waterlogging to prevent denitrification. In addition, avoid fertilizer application while the soil is wet.

As much as **30%** can be leached, or lost through soil moisture

Leaching, or washing away nitrogen, is the loss of water-soluble plant nutrients from the soil due to rain and irrigation. Nitrogen is highly mobile in the soil; nitrate leaching occurs when the nitrates are washed from the soil in drainage water. Nitrogen is more prone to leaching when soils are wet and pore spaces are saturated. Nitrogen leaching can have a negative impact on water quality—extremely high nitrate levels can lead to toxic water for humans and wildlife, especially newborn babies. Applying manure and nitrogen fertilizers when crops are actively growing, and using the nitrates for growth and development, will reduce the amount of nitrate in the soil system.

How nitrogen loss is prevented?

Products capable of delaying naturally occurring soil nitrogen transformation processes can lengthen the time that fertilizer nitrogen sources are available for plant uptake and improve nitrogen use efficiency (NUE).

- **Urease inhibitors** generally reduce nitrogen loss from ammonia volatilization when urea is placed on the soil surface.
- **Nitrification inhibitors** reduce nitrate loss to leaching or denitrification by keeping nitrogen in the ammonium form.

Since dramatic increases in the plant's nitrogen demand generally occur several weeks after application, the use of soil nitrogen stabilizers to control these naturally occurring nitrogen transformation processes can minimize nitrogen losses, increase NUE, and result in increased yield.

Signs and symptoms of nitrogen deficiency

It's important to keep an eye out for signs of nitrogen deficiency. Nitrogen deficiency in corn can be hard to recognize early in the growing season. However, throughout the plant's development, corn



V-patterned yellowing down the mid-rib of the leaves.

Photo courtesy of Ohio's Country Journal Online Edition



V-patterned yellowing down the mid-rib of the leaves.

Photo courtesy of University of Minnesota Extension Blog

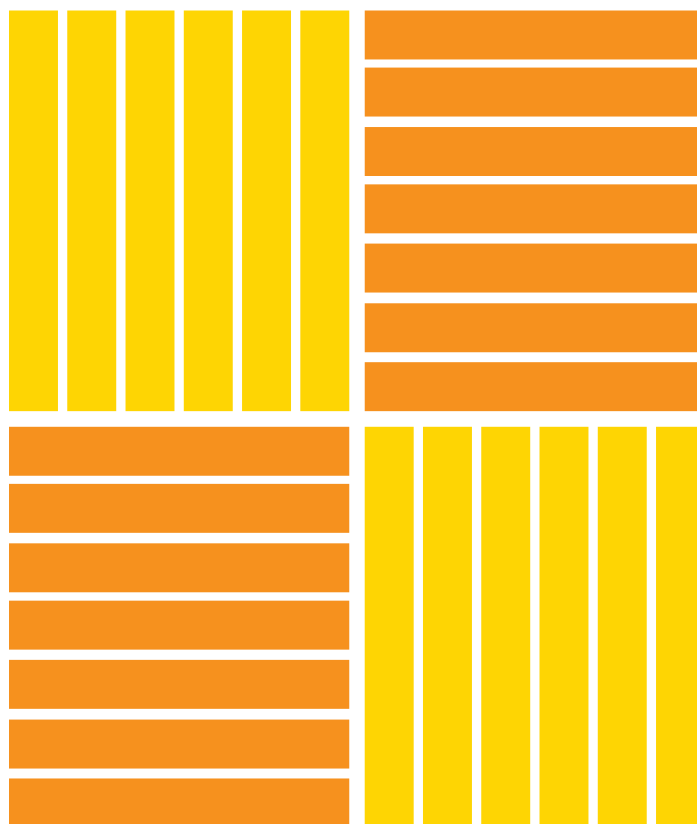
nitrogen deficiency becomes more visible through pale green leaves and thin stems. Other nitrogen deficiency symptoms are:

- The whole plant looks pale to yellowish green
- Early senescence of older leaves
- Increased root growth and stunted shoot growth results in a low shoot/root ratio

Utilizing soil tests

As farmers aim to increase productivity and yield each year, high-quality soil samples and informative soil tests provide a starting point of what nutrients are needed, what rate they should be applied at what time and place. Soil samples provide a report card of various nutrient levels in the soil and provides a layer of data information that helps to make better management decisions.

Fall soil testing is an important tool providing the data and information needed to assess the season after harvest and plan for the next growing season. Soil testing after harvest is the most practical because it allows for proper planning and budgeting for any corrections that need to be made in the soil for healthier crop next season.



Forms of nitrogen inputs

CHS offers multiple product solutions that help to reduce loss of nitrogen and protect your fertility investments. N-Edge® nitrogen stabilizer from CHS provides a valuable two- to three-week window of time for rain or incorporation to move fertilizer to the root zone, improving profitability and nutrient stewardship. N-Edge® nitrogen stabilizers protect fertilizer investment and are available to farmers through member cooperatives and agricultural retailers across North America. N-Edge, N-Edge 2 and N-Edge Pro reduce loss of nitrogen to the atmosphere and N-Edge Soil 2 keeps nitrogen available longer in the root zone.

Four forms of nitrogen inputs:

- **Urea:** A white crystalline solid containing 46% nitrogen as an animal feed additive and fertilizer. Urea can be applied to the soil as a solid, solution or a foliar spray. With a 46% N level, urea has a lower handling, storage and transportation forms than other dry N forms.
- **Urea-ammonium nitrate (UAN):** UAN solution is produced by combining urea, nitric acid and ammonia, is a liquid fertilizer product with a nitrogen content that ranges from 28-32%. UAN can be mixed with herbicides, pesticides and other nutrients, allowing farmers to reduce costs by applying materials simultaneously rather than making several separate applications.
- **Manure:** Manure is animal dung used for fertilizing land. It contains nitrogen, phosphorus, potassium and other nutrients. Nitrogen rich manure is a classic tool for promoting healthy plant growth. See below for the nitrogen composition in different manures to determine what will work best for you:
- **Anhydrous Ammonia:** Ammonia is an inorganic compound of nitrogen and hydrogen with the formula NH_3 . It is relatively easy to apply and is readily available to producers. Anhydrous ammonia is applied directly into the soil, as a pressurized liquid that immediately becomes a vapor after leaving the storage tank. Anhydrous ammonia should be injected at least 4 inches below the soil surface to prevent its loss as vapor back to the atmosphere.

Protecting nitrogen above and below ground

Above ground: NBPT stabilizers

N-(n-butyl) thiophosphoric triamide, commonly known as NBPT, is a urease inhibitor that protects against nitrogen loss through the volatilization stage of the nitrogen cycle. To protect nitrogen available to the plants above ground, use of NBPT slows down the process of urease enzymes breaking down and volatilizing into the atmosphere. When NBPT stabilizers are blended with urea it can provide above ground protection of applied nitrogen, protecting your fertilizer investment.

Below ground: DCD inhibitors

Nitrogen loss through the de-nitrification and leaching stages of the nitrogen cycle takes place below ground. To protect nitrogen available to plants below the surface, Dicyandiamide or DCD, a nitrification inhibitor, can be used to shut down and block the Nitrosomonas bacteria activity in the soil that is responsible for the conversion of ammonium to nitrite and then to nitrate, an unstable source of nitrogen for the crop.



Nitrogen management solutions

Security where it counts

There are a lot of ways that nitrogen can end up out of reach. To protect above-ground nitrogen from ammonia volatilization and below-ground nitrogen from denitrification and leaching, **CHS Agronomy** offers its **N-Edge** portfolio of nitrogen stabilizer products.

Use of N-Edge products, which can help protect against nitrogen loss, is especially critical during these situations:

- When fertilizer is surface applied, especially to moist soil.
- Under high crop residue, such as reduced or no-till conditions.
- When warm temperatures, high soil pH, and other weather and field challenges lead to increased nitrogen loss at or near the soil surface.



N·EDGE PRO

**BEHOLD THE PROTECTOR.
ONE PRODUCT, TWO MODES
OF ACTION.**

N·EDGE® PRO

N-Edge® Pro is a 17% NBPT and 23% DCD combination nitrogen stabilizer that can be applied to both above and below ground applications of urea and urea ammonia nitrate (UAN) to protect against volatility, leaching, and de-nitrification. N-Edge® Pro is your safety net, using dual modes of action to keep your nitrogen secure and safe from loss in both above and below ground nitrogen applications.

- Protects above ground nitrogen from ammonia volatilization.
- Protects below ground nitrogen from denitrification and leaching.
- Dual formulation and proven solvent offer enhanced mixing and handling.



Other N-Edge solutions



N·EDGE®

N-Edge® reduces nitrogen loss, providing a valuable window of time for rain, irrigation, or incorporation to move fertilizer to the root zone before volatilization occurs. This nitrogen stabilizer uses a proven active ingredient, NBPT, to increase the efficiency of urea or urea-containing fertilizers for all crops, turf and forestry by reducing nitrogen loss to the environment and increasing nutrient availability for plant growth.

- Protects above ground nitrogen from volatilization.
- NBPT inhibits activity of the urease enzyme that breaks down urea.
- Slows the conversion of urea to ammonia gas.

N·EDGE® 2

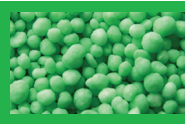



N-Edge® 2 reduces nitrogen loss, providing a three-week window for rain, irrigation, or incorporation to move fertilizer to the root zone before volatilization occurs. N-Edge® 2 contains a higher concentration of the active ingredient, NBPT, which provides an increased window of protection. This nitrogen stabilizer increases the efficiency of urea and urea-containing fertilizers for all crops, turf and forestry. It can be applied:

- Increased protection above ground from volatilization.
- NBPT inhibits activity of the enzyme (urease) that breaks down urea.
- Slows the conversion of urea to ammonia gas.

N·EDGE® SOIL 2

N-Edge® Soil 2 is a high-load DCD (dicyandiamide) nitrogen stabilizer that provides protection against leaching and denitrification with below ground applications of Urea and UAN.

- Protects below ground nitrogen from de-nitrification and leaching.
- Blocks Nitrosomonas bacteria activity in the soil that causes loss.
- Higher DCD percentage extends protection window.

Timing Application	Pre-Plant		Pre-Emergence		In Season	
	Injection		Surface Applied	Top-Dress	Side-Dress	
N Source	NH ₃	UAN	Urea UAN	Urea UAN	UAN	NH ₃
Above Ground Protection			N·EDGE® 26.7% NBPT		Urea: 3 qt/ton UAN: 1.5 qt/ton	
			N·EDGE® 2 40.4% NBPT		Urea: 2 qt/ton UAN: 1 qt/ton	
Above & Below Ground Protection			N·EDGE® PRO 17% NBPT 23% DCD		Urea: 3 qt/ton UAN: 1.5 qt/ton Manure: 8-32 oz/A	
Below Ground Protection			N·EDGE® SOIL 2 30% DCD Blue color can be added		N·EDGE® SOIL 2 NH ₃ : 5-7 qt/ton; Toolbar: 16-20 oz/A Urea: 3 qt/ton UAN: 2 qt/ton Manure: 1-2 pt/A	

Above ground protection = NBPT = Urease inhibitor & penetrating agent, prevents volatilization
 Below ground protection = DCD = Nitrification inhibitor, reduces leaching and denitrification

Retailer and grower opportunities

Now more than ever, it's important for retailers to stay engaged with their CHS Agronomy representative to stay up to date on the latest nutrient management practices in order to select the best solution for their operation and profitability.

To learn more about nitrogen management visit chsagronomy.com/blog, and for more on the N-Edge® line up, visit chsagronomy.com/CropProtection

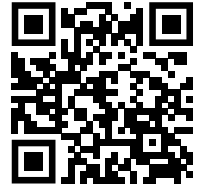
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5500 Cenex Drive ▪ Inver Grove Heights, MN 55077 ▪ 651-355-6000 ▪ chsinc.com

