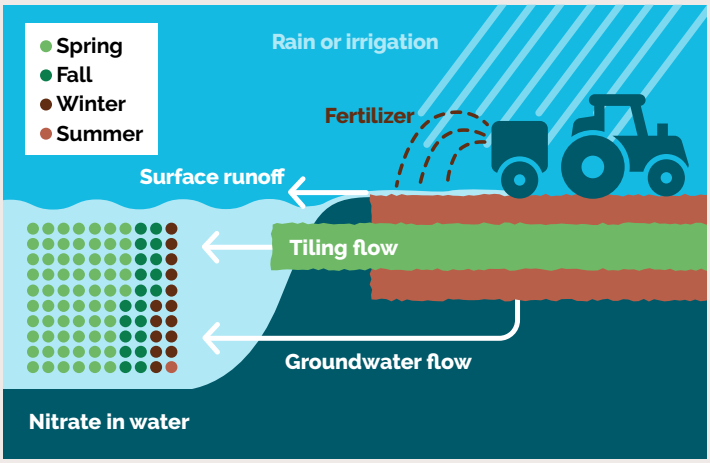
Digging Deeper

Limiting Nitrate Loss with Successful Nutrient and Cover Crop Management

Nitrogen loss from agriculture is a primary source of water quality issues in Illinois and Midwestern states. Management considerations such as 4R Nutrient Stewardship and integrating cover crops can help reduce the potential for loss throughout the year. In addition to helping reduce nitrogen loss, effective integration of cover crops can also provide significant soil health and agronomic benefits.



Nitrate loss occurs via surface runoff, drainage in tile lines, and leaching into groundwater. Around 65% of nitrate is lost during spring, before crops are present. Color-coded dots represent seasonal nitrate contributions.

In 2015, Illinois adopted its Nutrient Loss Reduction Strategy (NLRS) to address water quality challenges caused by the influx of nitrogen (N) and phosphorus (P) into aquatic systems. Agriculture is an important source of N and P, and this document outlines opportunities to better manage nitrogen in row crop systems.

When not used by plants, nitrogen fertilizer converts to Nitrate (NO_3^-), which is susceptible to leaching below the root zone and into drainage tile lines. When nitrate leaches to surface and ground water, issues can arise. Per the 2023 NLRS report, about 416 million lbs of nitrogen leaches from Illinois row cropland each year. Around 65% of this NO_3^- is lost through tile lines during the early spring when, traditionally, plants are not growing on cropland. Combining more sound fertilizer management and expanding plant cover throughout the year are key strategies to reduce N loading to waterbodies.

Understanding 4R Principles and Nitrogen Efficiency

The first line of defense against leaching is effective nitrogen management through 4R Stewardship.

Right Source

Utilizing multiple sources of N can provide opportunities for flexibility in an N fertility plan. Including nitrification inhibitors when necessary can also reduce loss.

Right Rate

Using nitrogen rate calculators such as the MRTN can help to dial in the total N requirement and avoid over application.

Right Time

Spring and in-season applications of N limit the amount of time that fertilizer N is vulnerable to environmental loss.

Right Place

Applying nitrogen directly in the root zone provides increased opportunity for root interception and uptake.

Even with 4R Stewardship, NO_3^- is prone to leaching when plants are not actively growing.

With weak bonds to soil and high solubility, NO_3^- in soil solution wants to move with water. The destination of this NO_3^- can either be leached to ground and surface water or taken up into plant roots. The integration of cover crop species extends the time that plant roots are growing and able to assimilate NO_3^- from soil solution. Winter hardy grasses are best suited for this NO_3^- scavenging, ensuring that NO_3^- will be cycled through the crop rotation instead of lost to water.

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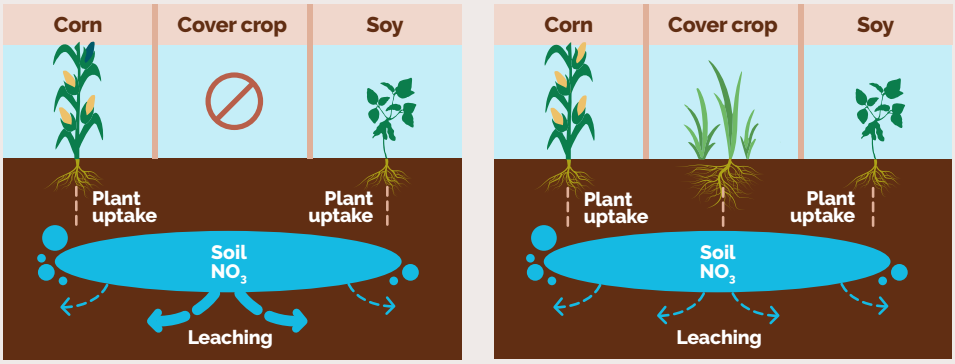

Including cover crops in a corn-soy rotation increases the amount of time roots are growing and reduces NO3- loss. Research on Illinois farms (Gentry et al, 2025) show that 1.5T biomass of cereal rye (approximately 16"-18" of vegetative growth), combined with spring / in-season N application, reduces tile NO3- loss by 45%.

In addition to reducing nitrate leaching, well managed cover crops also provide a suite of benefits. By increasing carbon and organic matter, cover crops stimulate microbial activity that builds soil aggregation. This aggregation improves stability, habitat, infiltration and water holding capacity. Legume cover crops will fix atmospheric nitrogen that can be used by the following cash crop, and biomass from grass cover crops can help suppress weeds.

Successful integration of cover crops requires careful consideration of the following:

- Which cash crop will be grown the following season
- Sufficient stand establishment influences performance of cover crop, and producers should select the seeding date and technique most appropriate for their goals. Cover Crop Seeding Methods Guide - Illinois Sustainable Ag Partnership
- Cover crop hardiness will influence springtime management requirements
- Termination timing of the cover crop impacts the C:N ratio, which affects nitrogen availability for the next cash crop. More Than Trash - Why Residue Matters - Illinois Sustainable Ag Partnership

Midwest Cover Crop Council Selector Tool is useful in making species selection easier by providing information on seeding rates, mixtures, planting and termination dates, and other considerations.

Key Characteristics of Commonly Used Cover Crops

Cover crop	Type	Hardiness	Characteristics	Rotation	C:N ratio
Cereal Rye	Grass	winter hardy	erosion control, soil builder, N scavenger	before soybean	30-82:1
Spring Oats	Grass	winter terminal	erosion control, soil builder, N scavenger	before corn or soybean	33:1
Barley	Grass	winter hardy	erosion control, soil builder, N scavenger	before corn or soybean	20-60:1
Crimson Clover	Legume	winter hardy	erosion control, soil builder, N fixer	before corn	15-20:1
Radish	Brassica	winter terminal	soil builder, N scavenger	before corn	12:1

Proper nutrient management and well planned integration of cover crops can help Illinois farmers improve soil health that sustains productivity and profitability while working to meet Illinois water quality goals.

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