The New York Nitrate Leaching Index

Nitrate loss to groundwater is primarily driven by rainfall and percolation potential of the soil. The extent of percolation depends on permeability, pore-size distribution, soil depth to a restrictive layer, artificial drainage, and precipitation amount and distribution over the year. To aid in identification of fields with elevated nitrate leaching risk and implementation of beneficial management practices (BMPs) to reduce nitrate loss, the Nitrate Leaching Index (NLI) was introduced for use in New York. This factsheet describes how to derive the NLI for a given field location and hydrologic soil group (HSG) and lists a variety of field and nutrient management practices that can help reduce the risk of nitrate leaching to groundwater.

Hydrologic Soil Groups and the NLI

The USDA-NRCS classifies all soils of the United States into four HSGs (A, B, C, D) based on runoff and percolation potential, determined using the rate of water infiltration when soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The depth and hydraulic conductivity of any water impermeable layer and the depth to any high-water table are used to assign a HSG to a map unit. Under identical precipitation levels, HSG "A" soils have the greatest percolation potential while HSG "D" soils are least conducive to leaching (Table 1).

Table 1. Soil Hydrologic Groups.

Soil Hydrologic Group	Type	Infiltration Capacity / Permeability	Leaching Potential
A	Deep, well-drained sands and gravels.	High	High
B	Moderately drained, moderately fine to moderately coarse texture.	Moderate	Moderate
C	Impeding layer, or moderately fine to fine texture.	Low	Low
D	Clay soils, soils with high water table.	Very Low	Very Low

Some soils are assigned HSG "D" based solely on the presence of a water table within 24 inches of the surface. When adequately drained, the runoff potential of these soils is reduced while leaching potential is increased. Such soils are assigned a dual HSG (e.g., A/D, B/D, C/D), with the first letter representing the adequately drained condition, defined as having a seasonal-high water table at least 24 inches below the soil surface. For NLI planning purposes, when a planner determines that adequate drainage is installed in a field, use the first HSG letter in the pairing.

Calculating the NLI

The NLI is calculated by multiplying the Percolation Index and the Seasonal Index for a particular location (township scale):

LI = Percolation Index * Seasonal Index

The Percolation Index is a function of the annual average precipitation and HSG. The Seasonal Index is based on the annual precipitation and the sum of the fall and winter precipitation (October through March). The NLI ranks the well-drained soils in areas of high rainfall with a higher potential for leaching.

Management Implications

A NLI below 2 indicates that the risk of nitrate leaching below the root zone is low. An NLI greater than 10 indicates a considerable risk of nitrate leaching, while the leaching risk is considered intermediate if the NLI is between 2 and 10. To meet the N leaching requirements of the NRCS 590 nutrient management standard, producers are *expected to implement* beneficial management practices (BMPs) if the NLI score for a field is high (>10) and *consider* the same practices on a case-by-case basis if the NLI score for a field is intermediate (2-10).

Beneficial Management Practices

A variety of field and nutrient management practices can help reduce nitrate leaching risk. Specific BMPs to be considered for soils

classified as intermediate and recommended for soils classified as high in the NLI include:

- Unless the New York Phosphorus Index identifies the need for P based fertility management or prohibits P applications, manure and fertilizer application rates should be based on Cornell University guidelines for N management of crops.
- If pre-plant or early post-plant *broadcast* application of N fertilizer in corn cannot be avoided, use of an enhanced efficiency N fertilizer (i.e., nitrification and/or urease inhibitors, controlled release fertilizers) is recommended.
- If starter N must be broadcast (e.g., for small grains or new grass seedings), apply N as close to expected planting date as possible (ideally within 3 days). Consider use of enhanced efficiency N fertilizer.
- For row and cereal crops, including corn, maintain starter fertilizer N rates below 50 lbs N per acre under normal conditions.
- Utilize split-applications of nitrogen fertilizer or manure whenever possible, aligning the timing of applications with crop utilization.
- To avoid pre-mature N fertilizer loss and to properly align with crop uptake efficiency for corn, sidedress applications should be made after plants have at least four true leaves.
- Use the pre-sidedress nitrate test (PSNT) to identify fields where sidedress N is unlikely to result in a crop response (see Agronomy Fact Sheet #3: Pre-Sidedress Nitrate Test).
- Manure N application on legumes is acceptable to satisfy agronomic requirements when legumes represent less than 50% of the stand. When legumes represent more than 50% of the stand, manure may be applied at rates no greater than 150 lbs of available N per acre or 85% of the estimated N removal with harvest.
- Minimize fall and/or winter manure application on grass and/or legume sod fields that are to be rotated the following spring.
- Sod crops should not be incorporated in the fall. Chemical sod killing may not be carried out until the soil temperature at 4-inch depth is at or below 45°F. Depending on location, this will not likely take place until October.
- Establish winter hardy cover crops (e.g., cereal rye, winter wheat, triticale) whenever possible, but especially when fall manure is to be applied to otherwise bare ground.
- Manure may be applied in the fall where there is a growing crop or in conjunction with seeding of winter hardy cover crops. Applications should generally not exceed the greater of 50 lbs/acre of first year available N or 50% of the expected N requirement of next year's crop.
- Frost injection of manure in fields with sod or winter hardy cover crops is acceptable when soil conditions are suitable, but winter applications should be made in accordance with the New York Phosphorus Index, the Groundwater Protection Guidelines for Agriculture, and the Revised Winter and Wet Weather Manure Spreading Guidelines to Reduce Water Contamination Risk.

In Summary

The NLI is designed to identify fields with elevated risk of nitrate leaching, determined by precipitation pattern and HSG. A variety of field and nutrient management practices can help reduce the risk of nitrate leaching to groundwater. Specific beneficial management practices include, among others, establishment of winter hardy cover crops, split application of N fertilizer and manure, and use of enhanced efficiency fertilizer technologies.

Additional Resources

- Cornell University Guidelines for CNMPs: nmsp.cals.cornell.edu/guidelines/nutrientguide.html.
- Groundwater Protection Guidelines for Agriculture: http://nmsp.cals.cornell.edu/publications/files/GroundwaterGuidelines2021.pdf
- The New York Nitrate Leaching Index: nmsp.cals.cornell.edu/publications/extension/NLeachingIndex2022.pdf.

Disclaimer

This fact sheet reflects the current authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.cals.cornell.edu

Quirine Ketterings, Kirsten Workman, Dale Gates, Josh Hornesky, Amy Langner (NRCS), Sara Latessa (NYSDEC), Ron Bush, Brendan Jordan, and Greg Albrecht (NYSAGM)

2022

(orginally released in 2006 with co-authorship by Karl Czymmek, Harold van Es, and Stephen DeGloria)