# Nitrogen Use

Working Metric Version 1.0 | Adopted July 31, 2013

Nitrogen is a key nutrient for crop production. However, when transported off the farm, it poses an economic loss to the grower and can have detrimental impacts to surface and groundwater quality. Nitrogen lost to the atmosphere as nitrous oxide ($N_2O$) is a potent greenhouse gas, with ~300 times the warming potential of carbon dioxide ($CO_2$). Both nitrogen and phosphorus were chosen for the nutrient metrics as they are widely recognized as pollutants and are a higher priority for environmental improvement than potassium (see separate Phosphorus Use metric).

The **Nitrogen Use** metric aims to capture the most significant sources of nitrogen being added to the farm system. It includes nitrogen from synthetic and organic fertilizers, nitrates dissolved in irrigation water, and nitrogen fixed from the air by leguminous crops. By accounting for all of these significant sources of nitrogen, a grower should be able to increase the efficiency of nutrient use in crop production.

**Metric**

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| **Nitrogen Use** | $$\frac{\text{Pounds N added to system}}{\text{Ton of product harvested}}$$ |
| | *Notes:*<br>- *N inputs include:*<br>*N applied* $_{synthetic}$ + *N applied* $_{organic}$ + *N applied* $_{irrigation\ water}$ + *N fixed* $_{leguminous\ crops}$<br>- *Includes all fertilization events from the end of the previous harvest to the current harvest (non-cash cover crops applied to subsequent cash crop).*<br>- *For educational purposes, metric can also be presented on a per-acre basis as:* **Pounds N added to system /acre planted** |

**<u>Recommended Issues to Consider in Future:</u>**

Through working group discussions, academic technical review, and Metric Technical Advisory Committee discussions, the following items have been identified as issues to be considered in future iterations of this metric:

- Percent of total N needs supplied from local or on-farm, organic material and/or biological resources (e.g., legumes, crop residue, cover crops, manure, compost)
- Synchrony of soil N supply by month relative to plant N needs per month (the higher the level of synchrony, the higher N use efficiency)
- Develop allocation method for organic N and P over multiple cropping periods to more accurately reflect their release times.
- Inclusion of N deposition from rainfall/the atmosphere as input

**<u>Technical Notes:</u>**

The Nitrogen Use Metric is calculated on a harvest-to-harvest timeframe as follows:

$$\textbf{Pounds N Added to System} = \textbf{N applied}_{synthetic} + \textbf{N applied}_{organic} + \textbf{N applied}_{irrigation\ water} + \textbf{N fixed}_{legumes}$$

Each component is further explained here.

<u>Component 1: N from Synthetic Fertilizers</u>

Nitrogen from both organic and synthetic fertilizers is included in the total for the P added component, evaluated as the total amounts applied during the harvest-to-harvest period. If the SISC Calculator is used, data is collected in the form of the N-P-K ratio for individual organic and synthetic fertilizers and pounds of N are determined by summing all product applications for each crop.

- All fertilizer applied during the harvest-to-harvest period should be included.
- If growers do not know the density of liquid fertilizers, an average density of 11.11 lbs/gal is used to convert liquid fertilizers into dry weight. This value was derived by averaging the density of several common liquid fertilizers as published by the Fluid Fertilizer Foundation. [1]

<u>Component 2: N from Organic Fertilizers</u>

- The entire nutrient value applied during the harvest to harvest cycle is attributed to the crop. While it is recognized that organic fertilizers often have slow-release properties, at this time SISC does not attribute applications to multiple crops.
- Where a nutrient analysis has been conducted, the N-P-K value from this analysis should be used. A protocol for how to convert from volume to weight and how to account for moisture content is described in Alternatives 1 and 2 of the Protocol for Estimating N and P for Organic Fertilizers (found on the metrics page).
- Where growers do not know the nutrient value of the material, they should follow Alternatives 3 or 4 in the Protocol for Estimating N and P for Organic Fertilizers (found on the metrics page).

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[1] "Estimated Physical Characteristics of Fertilizer Material", Fluid Fertilizer Foundation, http://www.fluidfertilizer.com/pdf/Fluid%20Characteristics.pdf

Component 3: N from Irrigation Water

Nitrate in irrigation water can account for one third of total crop N demand in some situations, but can be negligible in others.[2] Nitrate concentrations can tested using nitrate kits or through lab analysis. Nitrate concentrations below 3ppm are unnecessary to report.

- If nitrate concentration is known, multiply the concentration by the amount of irrigation water applied.
- If nitrate concentration is not known, follow the "SISC Metric Guidelines: Protocol for Sampling and Testing Nitrogen Concentration of Irrigation Water" found on the metrics page at www.stewardshipindex.org. The approach uses an initial series of simple, inexpensive tests to determine whether nitrate in irrigation water is a significant N input for the farm. If not, no further testing is necessary; if irrigation water appears to be a significant N source, additional testing is recommended particularly in the first year.
- Initially, both surface and groundwater irrigation sources should be tested to determine if they could be significant N sources.

Component 4: N from Leguminous Crops

Leguminous crops fix N in the soil. The amount of this contribution should be estimated by following the protocol in "SISC Metrics Guidelines: Estimating Nitrogen Fixation of Leguminous Crops" on the metrics page at www.stewardshipindex.org. The estimation approach requires the user to know only the rough height of the crop, approximate portion of the crop mix that is leguminous (for mixed cover crops), and an estimate of its maturity.

[2] Burow, K., et al. (2012). "Assessment of regional change in nitrate concentrations in groundwater in the Central Valley, California, USA, 1950s–2000s." Environmental Earth Sciences: 1-13.
Saad, D. A. (2008). "Agriculture-Related Trends in Groundwater Quality of the Glacial Deposits Aquifer, Central Wisconsin All rights reserved." J. Environ. Qual. **37**(5_Supplement): S-209-S-225.
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