

NITROGEN USE EFFICIENCY IN WISCONSIN

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Introduction

Calculating nitrogen use efficiency (NUE) on a field-by-field basis can be a valuable tool for assessing N management on a farm. There are four key ways to evaluate nitrogen: Partial Factor Productivity (PFP), Agronomic Efficiency (AE), Partial Nutrient Balance (PNB), and Recovery (or Uptake) Efficiency (RE). Table 1 provides calculations and interpretations.

Table 1. Definitions and calculations for four nitrogen use efficiency measurements.

<p>Partial Factor Productivity (PFP): Is this cropping system productive in comparison to nitrogen application?</p> $\text{PFP} = \frac{\text{Yield}}{\text{Amount of Nitrogen Applied}}$ <p>Higher PFP= more efficient use of nitrogen</p>
<p>Agronomic Efficiency (AE): Did fertilizer improve productivity?</p> $\text{AE} = \frac{\text{Yield} - \text{Yield with no applied nitrogen}}{\text{Amount of Nitrogen Applied}}$ <p>Higher AE= more efficient use of nutrients</p>
<p>Partial Nutrient Balance (PNB): How much nitrogen is being taken out of the system in comparison to how much is applied?</p> $\text{PNB} = \frac{\text{Nitrogen content of harvested portion of crop}}{\text{Amount of Nitrogen Applied}}$ <p><1= nutrient surplus, >1=nutrient deficiency, close to 1=minimal opportunity for losses</p>
<p>Recovery Efficiency (RE): How much nutrients applied did the plant take up?</p> $\text{RE} = \frac{\text{Nitrogen uptake in crop with nitrogen applied} - \text{nitrogen uptake in crop with no nitrogen applied}}{\text{Amount of Nitrogen Applied}}$ <p>Close to 1= most efficient</p>

However, it may also be valuable to assess the N balance of your system to see the total N that was not removed in the grain. The remaining N represents the amount that is likely to be lost to the environment, but part of which could also be stored in crop residues. Having a situation where there is relatively low efficiency and a high balance means that there is high potential for an economic benefit to changing N management practices. This can mean reduction in rate, or changing in timing, source, or placement (or a combination thereof) that would lead to more of the applied N ending up in the plant. Having an efficiency above 100% or a positive balance (i.e., removing more N than applied) can be OK in the short-term, but if continued over longer periods of time can lead to a reduction in soil organic matter. Based on results from around the

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Midwest, a nice goal to shoot for would be a partial factor productivity (PFP) of 80 (lb-grain / lb-N applied) and a partial nutrient balance of 90% (i.e., 90% of the N applied removed in the grain).

Nitrogen Use Efficiency Results in Wisconsin

Data reported in Figures 1, 2, and 3 are from on-farm assessments of nitrogen use efficiency collected during the 2015 and 2016 growing season. Measurements of yield and N content of grain were collected within a sub-section of a field.

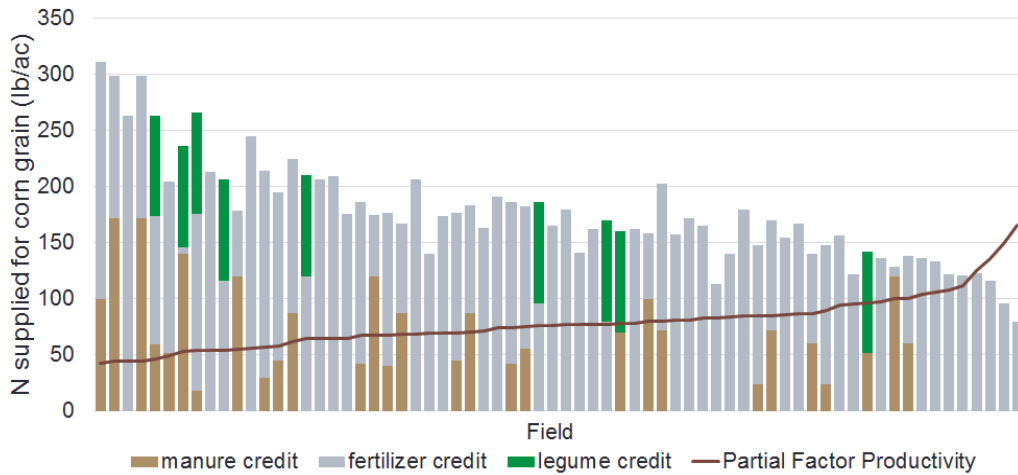


Figure 1. Total N application to corn grain (fertilizer, manure, and legume credits) and partial factor productivity (lb-grain / lb-N applied) for each field.

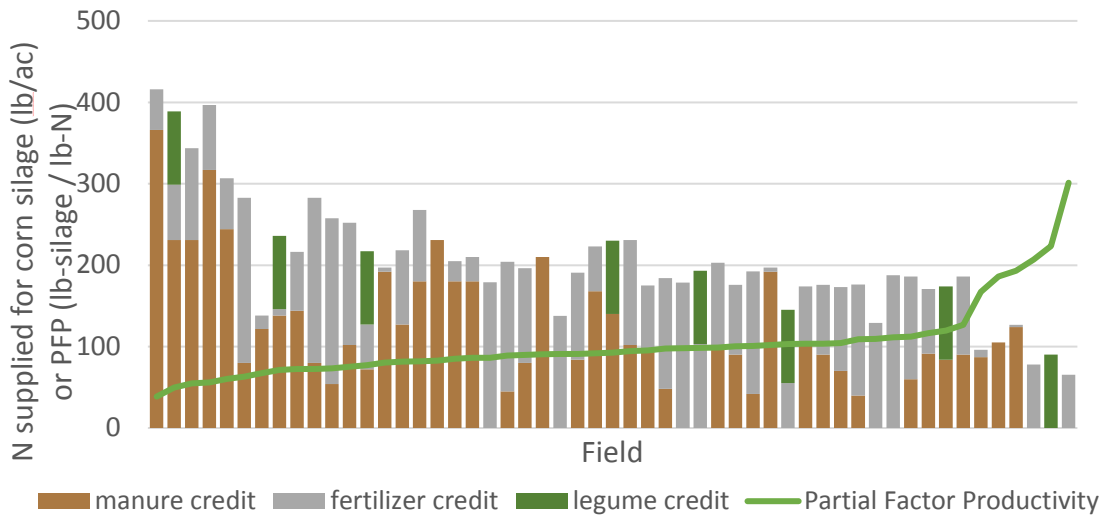


Figure 2. Total N application to corn silage (fertilizer, manure, and legume credits) and partial factor productivity (lb-silage / lb-N applied) for each field.

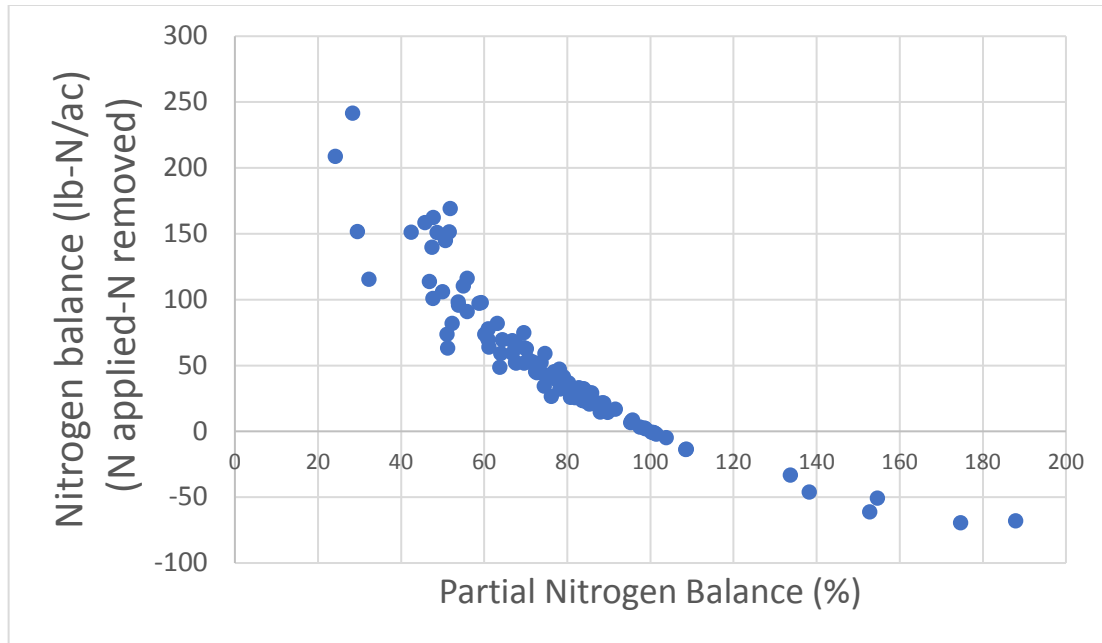


Figure 3. Relationship between partial nutrient balance (%) and actual N balance (lb-N/ac). Positive N balance indicates more N applied than removed. Partial nitrogen balance above 100% indicates more N removed than applied. Note that there can be quite a bit of variation in the N balance with the same PNB. This is driven by the yield; 60% PNB with high yields can lead to larger N balances than 60% PNB with low yields.

Summary

Currently we have 2 years of on-farm assessments and are currently analyzing 2017 results. This project will continue for at least 2 more years to develop regional benchmarks in Wisconsin. The data reported here can be viewed as a statewide benchmark. But, there will be some differences in region to region (and year-to-year) that will need to be accounted for to provide full value to producers and consultants.