Nitrogen Use Efficiency Results

April 2019

Nitrogen Use Efficiency (NUE) is a field level assessment tool that can be used to evaluate efficiency relative to other monitored fields and determine if a farm can make improvements to its nitrogen management. Since 2015, UW Discovery Farms has monitored 157 corn grain fields and 101 corn silage fields in nine regions of Wisconsin to create benchmarks specific to WI cropping systems and soils.

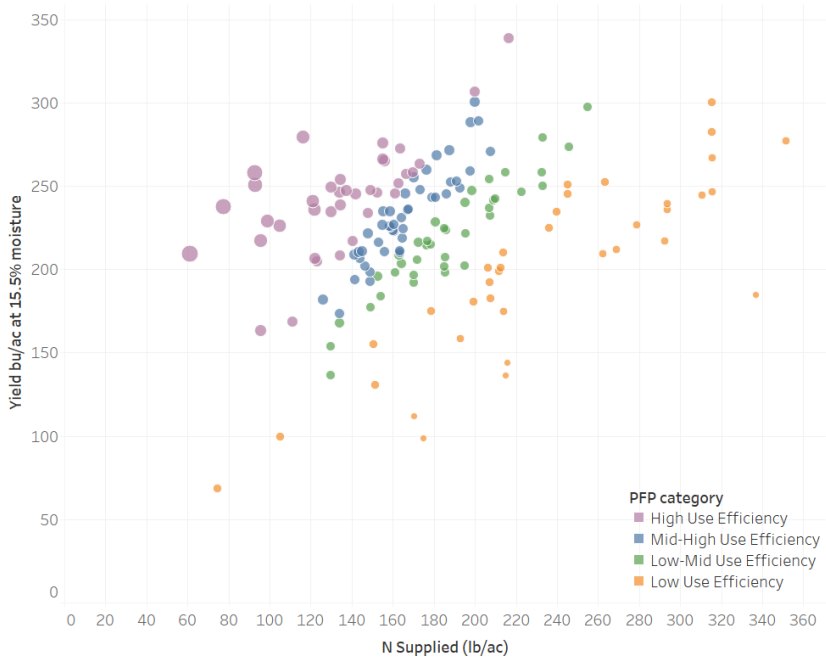
One way to understand NUE is to use Partial Factor Productivity (PFP), the calculation of Yield (lbs/ac) divided by nitrogen (N) applied (lbs/ac). Calculating PFP is the first step in a NUE assessment to evaluate how a field compares to others in the state and if improvements can be made. In this publication, NUE values are displayed based on PFP calculations.

More N does not always mean more yield, but it can affect your efficiency

Based on our data, we've grouped NUE into four efficiency categories: low use efficiency, low-mid use efficiency, mid-high use efficiency and high use efficiency. On monitored fields, N rates varied considerably and a wide range of yields were achieved across all rates. Figure 1 shows that on all of the grain fields monitored, there was no correlation between N supplied and yield.

A good range to fall in is the mid-high use efficiency category. A field with a high use efficiency and those with a low use efficiency can improve NUE by following recommendations in the Discovery Farms publication *Statewide benchmarking for Nitrogen Use Efficiency in corn grain and corn silage*.

Figure 1. Grain yield vs N supplied broken-down by efficiency category



High N rates can contribute to lower efficiencies

As depicted in Figure 1, many fields in the low use efficiency category have either very low yields or high N rates, which could be responsible for lower efficiencies. Ten percent of all monitored grain fields applied over 250 lb N/ac, all but one of which had an NUE categorized as low use efficiency. While the majority of fields that had NUE categorized as mid-high use or high use efficiency have N rates less than 170 lb N/ac (the average N rate of monitored grain fields), there are fields that applied low rates and had lower efficiencies as well as those that applied above 170 lb N/ac and had higher efficiencies. N rate is only one influencing factor of NUE. In the silage data set, the average N rate was 190 lb N/ac and rates overall tended to be higher than the monitored grain fields. However, we observed the same trend where very high N rates caused fields to have low or low-mid NUE.

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Wisconsin's use of organic N sources makes our NUE dataset unique

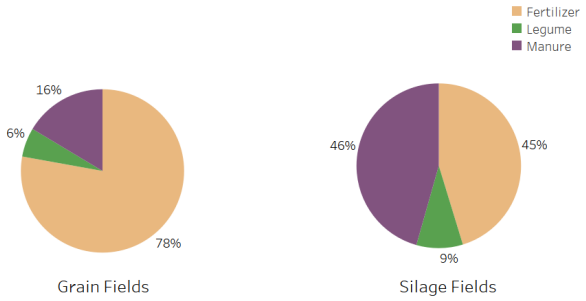


Figure 2. Percentage of N applied for grain and silage by source

While most NUE research looks at corn production that just uses fertilizer N, WI systems use a lot of manure and legumes for N. On monitored grain fields, nearly 25% of total applied N (lbs/ac) was in the form of manure or alfalfa. For our silage dataset, over 50% of total N applied is from manure or alfalfa. Using these other sources of N creates a challenge for N management and contributes to lower efficiencies, highlighting the need for WI-specific benchmarks and separate corn grain and silage datasets.

Multiple N sources can be a challenge to achieving mid-high use efficiency

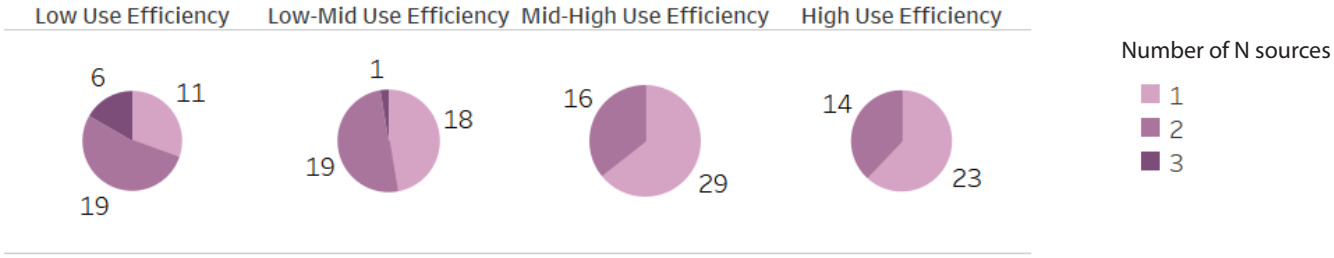
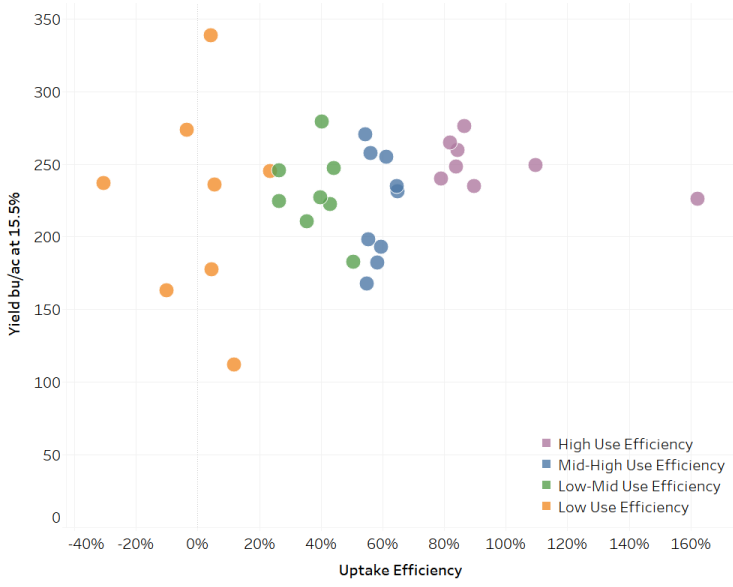


Figure 3. Grain fields broken down by efficiency categories and number of N sources

In both the grain and silage datasets, fields that use multiple N sources tended to have lower efficiencies. For the grain fields (shown in the graph), the majority of fields with NUE categorized as low or low-mid use efficiency used N from two or more sources (fertilizer, manure, and/or legume). In our silage dataset, only 20% of fields only used fertilizer as an N source because these systems include more manure and alfalfa in the rotation. All but one field that used N from all three sources had NUE categorized as low use or low-mid use efficiency. Fields that used two sources were equally represented in all efficiency categories.

Intensively monitored corn grain fields had a median Uptake Efficiency (UE) of 54%

Figure 4. UE of fields that included a zero-N test strip by yield at 15.5% moisture broken-down by efficiency category



In the Discovery Farms dataset, 34 corn grain fields were intensively monitored with a zero-N strip, which is a small strip that does not receive applied N (or at most 30 lbs N/ac, which is applied as starter). One measure of NUE, Uptake Efficiency (UE), calculates the percentage of applied N that is taken up by the corn crop in the total above ground biomass.

Since we monitored fields over different years, weather conditions, soil types and management styles, we observed a large range in UE values. The median value for corn grain was a UE of 54%, meaning 54% of applied N was taken up by the crop and, on the contrary, 46% of applied N was not utilized by the crop and has potential to be lost to the environment or transformed into another form of N. The middle fifty percent of data had a UE between 26% and 70%. Currently the data does not show any correlation between UE and management practices relating to soil health. Discovery Farms is continuing to monitor zero-N strips to assess this relationship.