Benchmarking the nitrogen use efficiency for corn production in Wisconsin

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Introduction

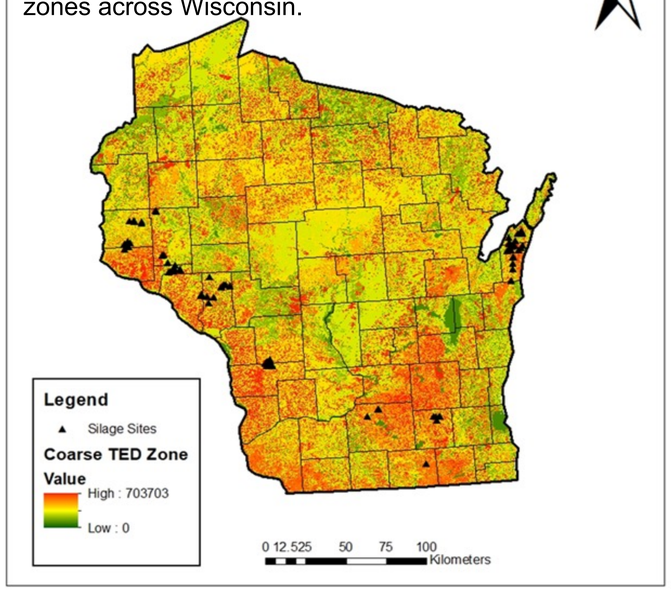
- A grand challenge for modern agriculture is to produce more per acre of land while reducing nitrogen losses to the environment.
  However, we have little information on how efficient we are currently being with nitrogen in Wisconsin.
- Benchmarking nitrogen use efficiency and nitrogen balances in Wisconsin corn production is the first step in identifying how efficient we can be.

Objectives

- Benchmark nitrogen use efficiency and balances in corn production in Wisconsin using an unstructured sampling design, which surveys working farm fields.

Fig 1. Data collection for corn silage and grain

Fig 2. Sampling locations (black dots) and spatial distributions for sampling zones for silage in TED-zones across Wisconsin.



TED Zones are useful in determining which soils are similar to others.

Equations

Partial factor productivity (PFP) =

Yield (lb/ac) / N applied (lb/ac)

Nitrogen balance =

N applied – N removed

Results – CORN SILAGE

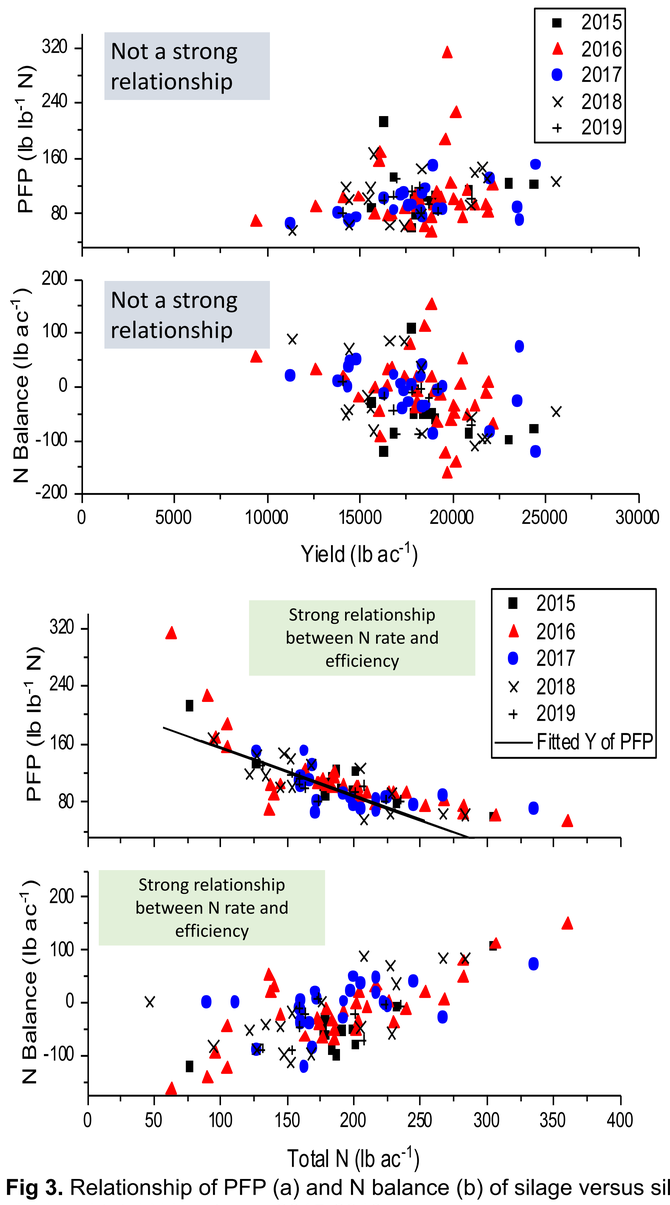


Fig 3. Relationship of PFP (a) and N balance (b) of silage versus silage yield and total N input over 2015-2019.

- Yield only represents about 6% and 14% of the variation in PFP and N balance for corn silage, respectively.
- Total N input explains more than 60% of the variation in PFP and N balance for corn silage, proving its role as the main driver for NUE.

Results – CORN GRAIN

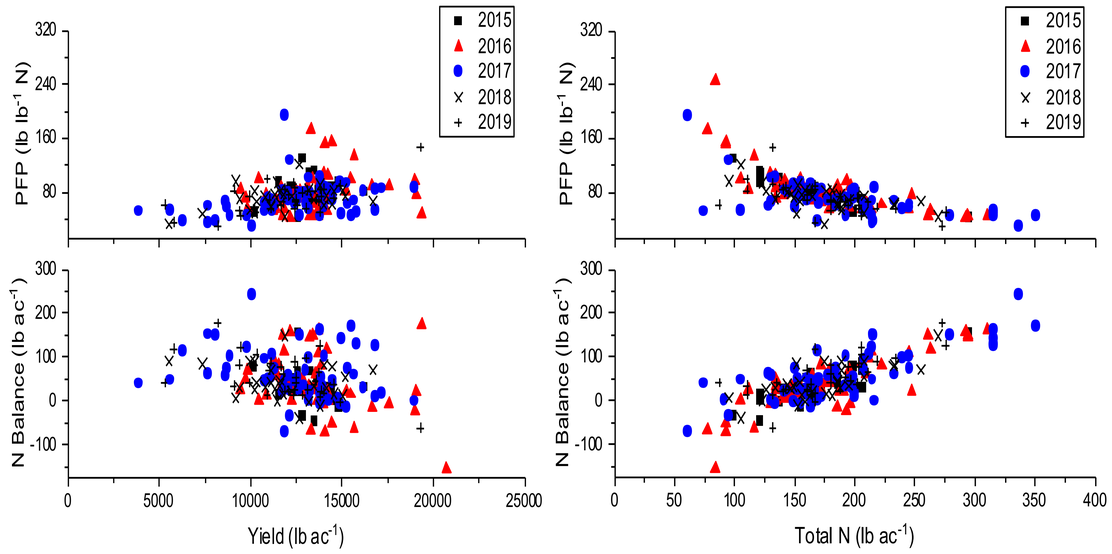


Fig 4. Relationship of PFP (a) and N balance (b) of grain versus grain yield and total N input over 2015-2019.

- Total N input is also the major driver of efficiency in corn grain production.

Results – Considering other factors

Table 1. Analysis of variance for the effect of technology extrapolation domain (TED), Tillage Category, Total N, and their interactions on yield, nitrogen (N) inputs, partial factor productivity for N inputs (PFP) and N balance.

		Percentage of total sum of squares (%SS)		
Source of variation	d.f.	PFP (lb lb^{-1}N)		N balance (lb ac^{-1})
TED (soil zone)	2	1.3		4.4
Tillage Category	2	1.0	Bigger values mean greater importance	1.3
Total Nitrogen Applied (TN)	**2**	★ **90.2**		★ **76.1**
TED * Tillage	4	3.3		11.9
TED * TN	3	1.0		1.1
Tillage * TN	2	2.3		2.2
TED * Tillage * TN	3	0.9		3.1

- Even when considering other factors such as soil properties and tillage, the total amount of N applied remains the top factor for efficient N use in Wisconsin. Statistically speaking, the N rate alone accounts for 76 of the variation in the N balance and 90% of the variation in efficiency.

CONCLUSIONS

- For both silage and grain, total N is the controlling factor for efficiency and the resulting N balance of a system.
- Compared to climatic factors, total N input also plays a bigger role during silage production.
- On-farm data collection with farmers could be promising to narrow down effective N input and management practices.
- **To improve overall efficiency of nitrogen use in Wisconsin, we must develop site-specific N rate optimization recommendations.**