

NITROGEN USE EFFICIENCY HELPS EVALUATE 4R PRACTICES IN WHEAT



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One of the principles of 4R Nutrient Stewardship is the inclusion of performance indicators. Performance indicators are parameters that can be used to objectively evaluate outcomes from a specific set of management practices selected for a given cropping system. The performance indicators are chosen based on the sustainability goals for the production system. Nitrogen use efficiency (NUE) is a commonly used indicator to assess N management; however, it is important to note that NUE can be defined many different ways.

Estimating NUE on the farm can be as simple as measuring yield. One of the most basic methods for determining NUE is called *Partial Factor Productivity* (PFP), which is calculated as units of crop yield divided by units of nutrient applied. For example, applying N fertilizer at 90 lb/A to produce a 70 bu/A wheat crop would result in a PFP of approximately 47 units of grain per unit of applied N [i.e., (70 bu/A

x 60 lb/bu) / 90 lb N applied/A]. Published literature suggests that a PFP of 40 to 80 is considered typical for cereals.

Another easy strategy for estimating NUE considers nutrient removal in the harvested portion of the crop. The ratio of nutrient removed to nutrient applied is called a *Partial Nutrient Balance* (PNB). Using the above example and an N removal estimate of 1.15 lb N/bu for winter wheat (<http://ipni.info/calculator>), the PNB for this crop would be calculated as 0.93 [i.e., (70 bu/A x 1.2 lb N removed/bu) / 90 lb N applied/A]. A PNB equal to or very close to 1.0 suggests an efficient system, while values well below 1.0 might suggest the need for improved NUE. Conversely, a PNB much over 1.0 could suggest nutrient mining from the soil and a need for increased fertilizer application in the future.

The PFP and PNB are easily calculated for any farm that keeps records of

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inputs and outputs, and provide useful information for growers. However, neither method considers inherent soil nutrient supplies. It is also important to remember that nutrients are applied to improve the overall performance of the cropping system and NUE is only one aspect of that performance and must be interpreted within the context of the cropping system and other production goals.

NUE can be used as a performance indicator to evaluate the effect of 4R practices on wheat production goals for grain yield and protein content.

There are four possible scenarios that wheat farmers can encounter regarding grain yield and protein.

- 1) High grain yield and high protein content
- 2) High grain yield, but with low protein
- 3) Low grain yield and low protein content
- 4) Low grain yield, but high protein

Each of these scenarios in and of itself can tell the farmer something about the N status of the crop, but including NUE in the post-harvest analysis can shed even more light on the effectiveness of the practices. For example, consider **scenario 1**. Both production goals were met; but if the NUE was low then the N rate could possibly be reduced without compromising yield and protein. Without considering NUE, these practices might have

been considered ideal since yield and protein goals were met. In **scenario 2**, a high NUE might indicate that the N rate was too low and the crop had enough to achieve the yield goal but ran short in meeting the protein goal. A low NUE in this scenario would also indicate an N deficit to the plant, but it was more likely due to in-season loss of applied N and a timing or source change might need to be made. **Scenario 3** typically indicates an under-application of N and NUE is usually high, but when it is low the poor production could be due to non-N related stress factors such as drought, flooding, disease, etc. **Scenario 4** is also often a result of non-N stresses and NUE in this case will usually be low.

Of course, these examples are not all-inclusive and production issues revealed by performance indicators should always be validated with good ground truthing and diagnostic analyses when appropriate.

Estimating NUE on the farm is a good way for growers to evaluate 4R practices and identify problems in the system that may require their attention. However as the above examples indicate, high NUE does not necessarily indicate that the cropping system is operating most effectively. 4R practices that affect NUE must always be evaluated in the context of the total cropping system and their ability to meet production goals.