# Precision nitrogen management: Developing science-based practices

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Increasing nitrogen (N) use efficiency (NUE) through the use of precision technologies (e.g., GPS, remote sensing, yield monitors, and variable rate application) will require increased scientific understanding of landscape-scale processes and their impacts on decision making (Figure 1). Specifically, we are assessing yield-water-NUE relationships among diverse environments to elucidate site-specific processes that regulate the environmental and economic performance of wheat-based cropping systems. This effort will produce grower-oriented, site- and time-specific tools required to formulate N-efficient and environmentally sound conservation strategies, including tools for N management monitoring, decision making, and evaluation.

**IMPACT**

Our expectations are to develop science-based decision aids that improve the application of precision nitrogen management strategies in wheat. Specifically, we seek advances in the determination of economic management zones, precision nitrogen application rates, and site-specific assessments of wheat performance (crop and economic evaluation).

Stakeholders include growers, researchers, students, the public, and policy makers interested in the science and methodology of increasing NUE in dryland cropping systems of the REACCH region. Integration with economic and crop modeling efforts, as well as with the Site-Specific Climate Friendly Farming project (funded by the U.S. Department of Agriculture, National Institute of Food and Agriculture), is essential and on-going.

Our overall goal is to develop science-based decision aids for the application of precision N management strategies in wheat. In particular, application of precision technologies and strategies require advances in the determination of economic management zones, precision N application rates, and site-specific assessments of wheat performance (crop and economic evaluation). We are pursuing this goal through the integration of crop (e.g., yield monitoring), soil (e.g., apparent electrical conductivity), remote-sensed (e.g., Rapideye satellite imagery), and economic data using field-scale studies at the Washington State University Wilke Farm and Cook Agronomy Farm and at on-farm locations. More specifically, we are: (1) measuring field-scale, site-specific wheat performance and related variables (yield, protein, economic return, N status, NUE, soil organic matter, and inorganic N) required for precision N management decisions, and (2) developing and

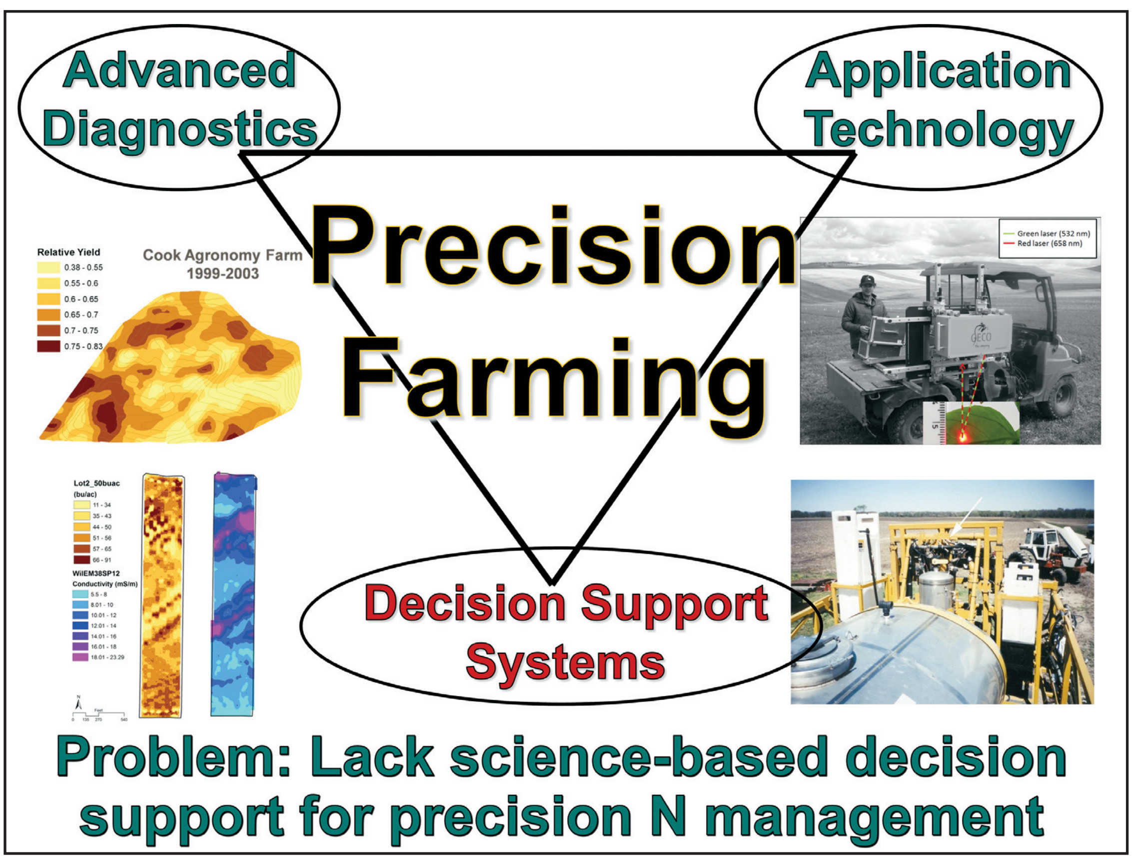



**Figure 1.** *Successful adoption of precision farming requires that advanced field diagnostics and application technologies be coupled with science-based decision support systems.*

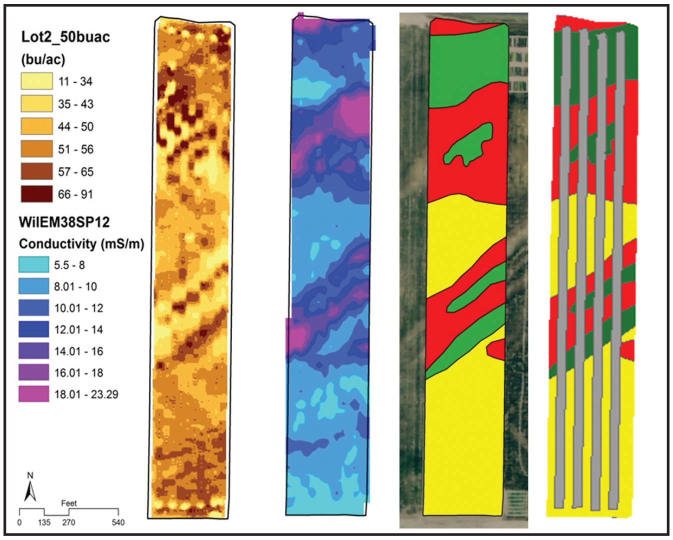


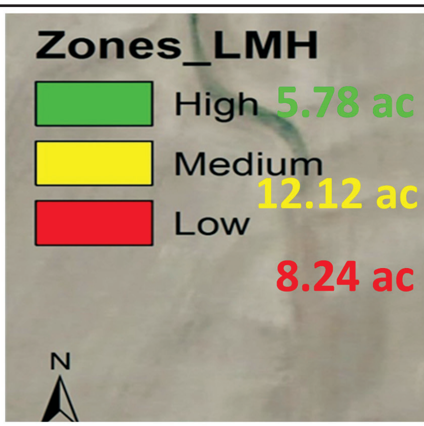

**Figure 2.** *Grain yield monitor (A) and apparent electrical conductivity data (B) from a 26-acre Wilke Farm field were used to create nitrogen management zones (C) with high (green), medium (yellow), and low (red) yield goals. Control strips with uniform applications of nitrogen are depicted in gray (D).*

**Figure 3.** *Yield goals, applied nitrogen, and resultant yield and grain protein concentrations. Actual yield and protein at the field level is shown on the lower far left, with a comparison between uniform (Uni) and variable rate (VRT) nitrogen application. Tables on the far right compare actual yield and protein by zones (green for high, red for low) for upper (upper right) and lower (lower right) areas of the field.*

testing site- and time-specific decision-aid and evaluation tools, including an economic assessment required by growers to formulate and assess science-based precision N recommendations.

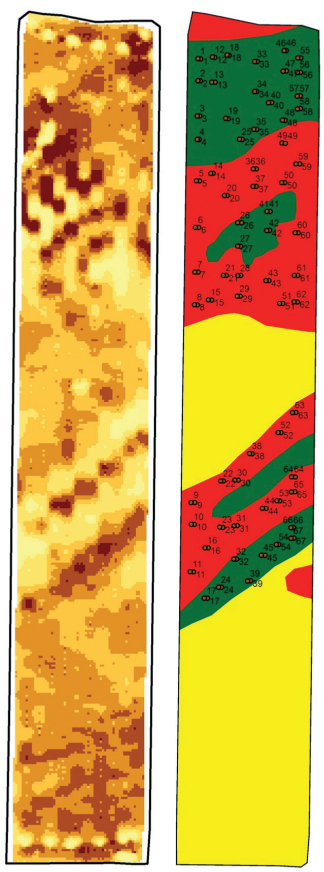
A 26-acre strip at the Wilke Farm was used for a precision N study in 2012. Grain yield monitor (1 year) and apparent electrical conductivity (Geonics EM-38) data were used to establish three N management zones with low, medium, and high yield goals (Figure 2). Variable rate N was applied during seeding of hard white spring wheat. Overall field averages for yield and protein were very similar for the two N application strategies (Figure 3). The N balance index (N removed in harvested grain divided by N fertilizer applied) was greater for the variable rate (VRT) treatment (0.99) as compared to the uniform (Uni) treatment (0.82). Preliminary economic analyses show that the VRT strategy was more economical on three of four "high" zones and two of three "low" zones.

Other data still under assessment include field soil water and inorganic N from comparative point samples as well as satellite imagery. These data will be used to further assess N and water use efficiency as well as the effectiveness of defining the three VRT zones. We repeated a similar experiment on this field, as well as another field at the Wilke Farm, in 2013. In addition, precision farming strategies are also being evaluated at the Cook Agronomy Farm and on four on-farm locations as part of the Site-specific Climate Friendly Farming project (SCF) led by Dr. David Brown (Washington State University).




| | Yield Goal | N Applied |
|---|---|---|
| High | 72 bu | 90 lbs |
| Med | 61 bu | 60 lbs |
| Low | 59 bu | 30 lbs |

| | Uni | VRT |
|---|---|---|
| Yield | 47 bu | 47 bu |
| Protein | 10.8 | 11.0 |



| | Uni | VRT |
|---|---|---|
| Yield | 52 bu | 54 bu |
| Protein | 10.7 | 11.2 |

| | Uni | VRT |
|---|---|---|
| Yield | 45 bu | 40 bu |
| Protein | 11.9 | 10.7 |

| | Uni | VRT |
|---|---|---|
| Yield | 40 bu | 40 bu |
| Protein | 13.1 | 11.8 |

| | Uni | VRT |
|---|---|---|
| Yield | 44 bu | 48 bu |
| Protein | 10.6 | 11.2 |