Project summary

We will leverage the Science for Success team, a coalition of nationwide soybean specialists, to quantify soybean nitrogen (N) credits across the United States (US). Soybean plays a critical role in enhancing soil N availability and are thought to reduce fertilizer inputs for subsequent non-legume crops. Soybean residues often decompose rapidly due to their low carbon-to-nitrogen ratio (C:N $\leq$ 25:1), releasing biologically fixed N that can reduce the need for synthetic N fertilizer application to subsequent non-legume crops. Despite this importance, no previous research has systematically quantified N credits on a national scale using a fallow control. Accurately quantifying N credits will provide robust agronomic data, improving both economic benefits, such as reduced fertilizer costs, and environmental advantages, including reduced greenhouse gas emissions, both of which factor into sustainability metrics.

1.2 Goals and objectives

The goal of this project is to quantify soybean N credits across representative soybean-growing regions of the USA.

1.3 Project deliverables

1) At harvest, we will collect soybean residue from the field experiment from 15 states across the US and analyze it for total C and N.
2) We will quantify the N mineralized from soybean residue over time
   - Surface and buried litterbags with soybean residue across a north-south transect will be used to quantify the N mineralization rates over time and space.
3) We will disseminate our results to farmers and other stakeholders through the United Soybean Board Science for Success initiative.
   - Produce at least 1 fact sheet, 1 webinar, and 5 videos by project completion.
4) Train next-generation soybean researchers and agronomists
   - Train at least one PhD student and 10 undergraduate students by project completion

1.4 Benefits to soybean farmers

This project has the potential to save soybean farmers money by applying soybean N credits to subsequent non-legume crops. For example, if the N rate to a subsequent nonlegume could be reduced by 20 lbs N/acre while maintaining yield, at current prices ($663/ton of urea), a farmer would save $14.41/acre. Current N credit recommendations need to be revised, particularly in light of new soybean varieties, management practices, record yields, and changing weather patterns. This project is expected to provide a robust framework to quantify N contributions from soybean residue using modern cultivars and management practices representative of soybean farmers across the USA. It will also inform the soybean sustainability initiative by quantifying the reduced fertilizer requirements for crops in rotation with soybean.

Methods

Project update

This project follows a two-year crop rotation as illustrated in Figure 1. In year 1 (2024), we established the history treatments (corn, soybean, and summer fallow). In year 2 (2025), corn was planted, and six N rates (0, 75, 150, 200, 250, and 300 lbs/ac) were applied between V4-V6 to quantify the nitrogen credits from soybean to the subsequent non-legume crop. These trials are being conducted across 14 states (MS, OH, SC, WI, NC, IA, MO, MI, IN, AL, NE, AR, TN, and LA), as shown in Figure 2. In 2025, we are excited to have an additional site at Virginia Tech (VT), managed by Dr. Carrie Ortel, a soybean specialist. History treatments were established at the VT site in 2025, which will contribute one additional site-year of data and increase our total number of research locations to 15 (Figure 2).

In order to approach the research question from another angle, we will conduct a decomposition study using post-harvest soybean residue enclosed in nylon mesh bags across a north-south transect at a rate equivalent to 13,382 lbs ac^{-1} to quantify the N mineralization rates across five states (MS, MO, MI, NE, and IN), as shown in Figure 2.

Figure 1: Schematic diagram of a two-year crop rotation cycle (repeated twice) illustrating crop history establishment during Year 1 (corn, soybean, and fallow) followed by Year 2 (corn with six nitrogen rates).

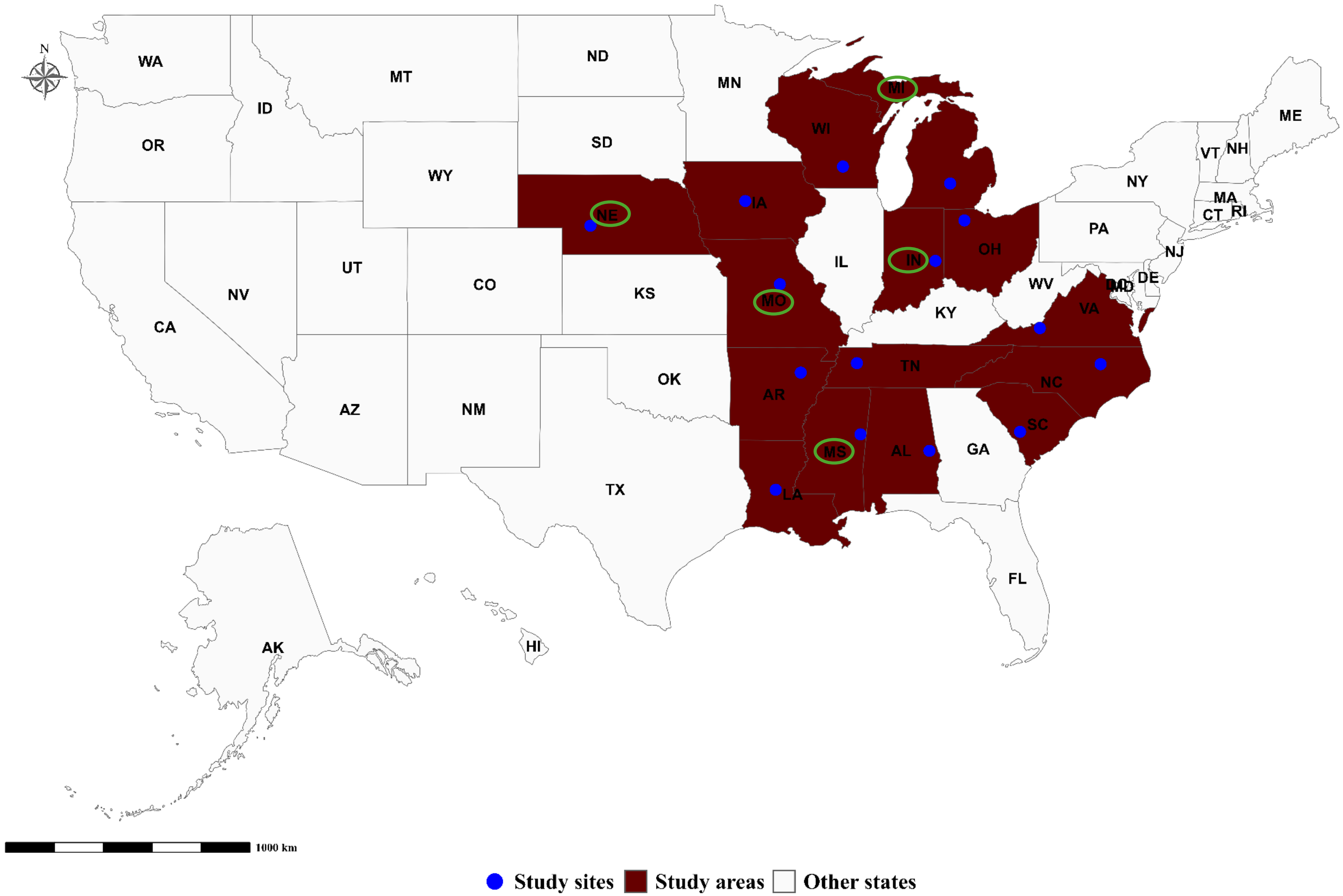


Fig. 2: Field trial locations in 2025 (shaded in maroon) and individual experimental sites (blue dotted points). States participating in the decomposition trial are shown in green circles.

Collection of time-zero soil samples

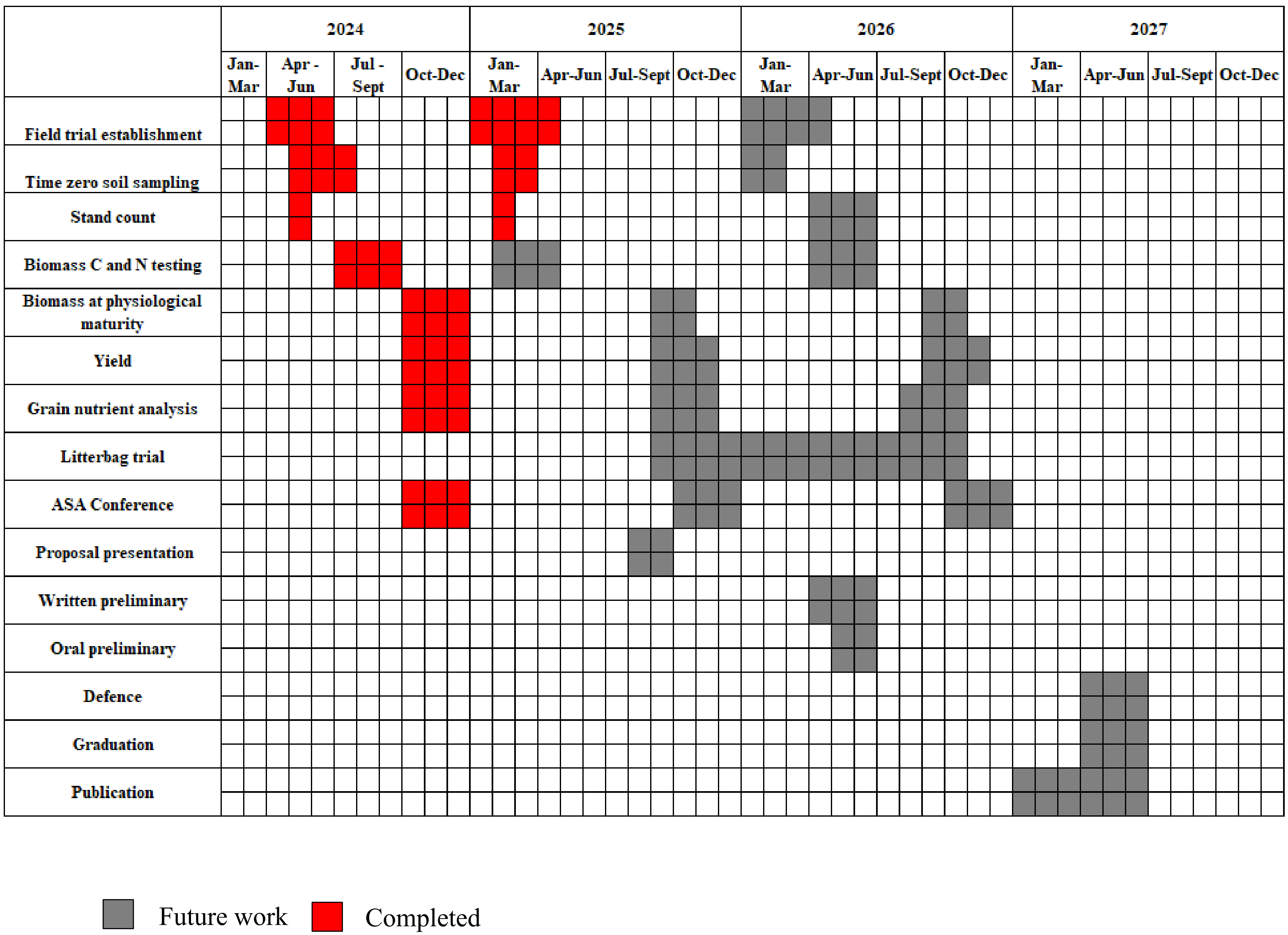
A critical component of our research involves collecting soil samples at "time zero" (0 to 6 inches), which represents the baseline soil conditions before the planting of the subsequent crop from both year one and year two of the project. Our research teams have collected soil samples from each trial site in the 15 states. The sampling process was standardized to ensure consistency across all locations.

Soil samples were taken from multiple points within each field. Within a site, samples were collected at 0-6 inch depths and bulked to obtain homogeneous samples. Samples were immediately stored in cool, dry conditions and labeled with key information, including the location and date of collection. Both organic and inorganic nitrogen forms were measured to determine the total nitrogen available in the soil. Samples will provide native soil C:N ratios, which will inform the potential for soil mineralization or immobilization of crop residues. Samples were also analyzed for texture, pH, CEC, and plant-available nutrients using the Mehlich 3 extractant.

Residue decomposition

We have procured supplies for residue decomposition studies, including litterbags, heat sealer, ground staples, and embossed aluminum tags. These have been sent to five sites (Fig. 2). This trial is ready for initiation after soybean harvest.

Overall timeline



References

Cochran, V. L. (1991). Biology and fertility of soils decomposition of barley straw in a subarctic soil in the field. *Biology and Fertility Soils*. 10: 227–232.

Jani, A. D., Mulvaney, M. J., Enloe, H. A., Erickson, J. E., Leon, R. G., Rowland, D. L., & Wood, C. W. (2019). Peanut residue distribution gradients and tillage practices determine patterns of nitrogen mineralization. *Nutrient Cycling in Agroecosystems*. 113(1): 63–76. https://doi.org/10.1007/s10705-018-9962-2