The effect of nitrogen-fixing bio-inoculants in corn cropping systems

Nitrogen is a vital nutrient for corn, fueling critical processes like photosynthesis and protein synthesis, which are essential for plant growth and yield. However, conventional corn farming often relies on synthetic nitrogen fertilizers to meet this demand. These fertilizers, while effective, are inefficient: much of the nitrogen they supply is not absorbed by the plants but instead escapes into the environment, leading to various ecological issues.

One of the most significant environmental consequences of synthetic nitrogen fertilizers is the release of nitrous oxide (N_2O), a potent greenhouse gas with approximately 300 times the global warming potential of carbon dioxide. Nitrous oxide is primarily produced when excess nitrogen from fertilizers breaks down in the soil. Agriculture is a major contributor to N_2O emissions, with the U.S. agricultural sector responsible for nearly 75% of the nation's N_2O emissions. Reducing these emissions is critical for mitigating climate change and improving the sustainability of agricultural practices.

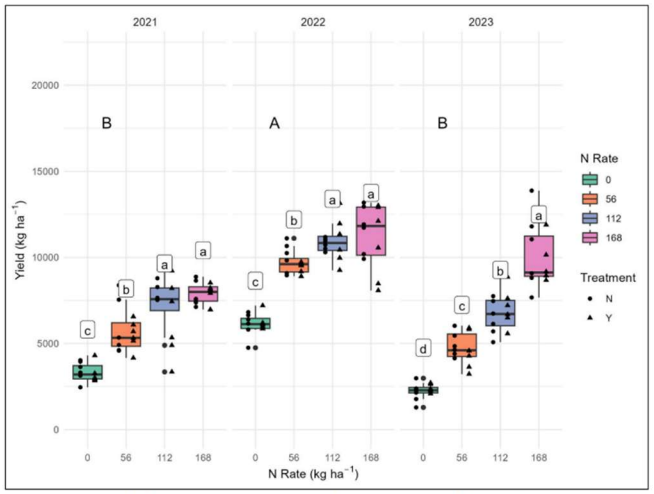
Our Research Focus

In light of these challenges, our research at Kansas State University's North Farm sought to evaluate an alternative approach: the use of nitrogen-fixing bio-inoculants. Specifically, we tested a product called Proven®, which contains beneficial bacteria that colonize the root zone of corn plants. These bacteria capture nitrogen from the atmosphere and convert it into a form usable by plants, potentially reducing the need for synthetic fertilizers.

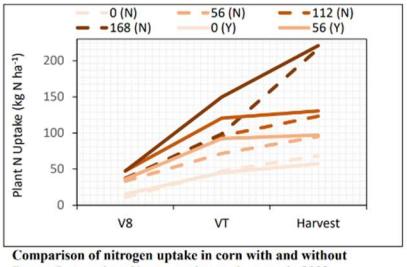
Study Outcomes

Over the course of three growing seasons, we assessed the impact of Proven® on nitrogen use efficiency, nitrogen uptake by the corn plants, and overall grain yield. While Proven® did not consistently increase corn yields, it showed promising results in specific growth

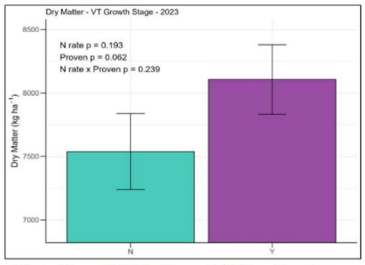
stages, particularly early in the season, when treated corn demonstrated higher nitrogen absorption.



Corn grain yield over three years by nitrogen rate and Proven®

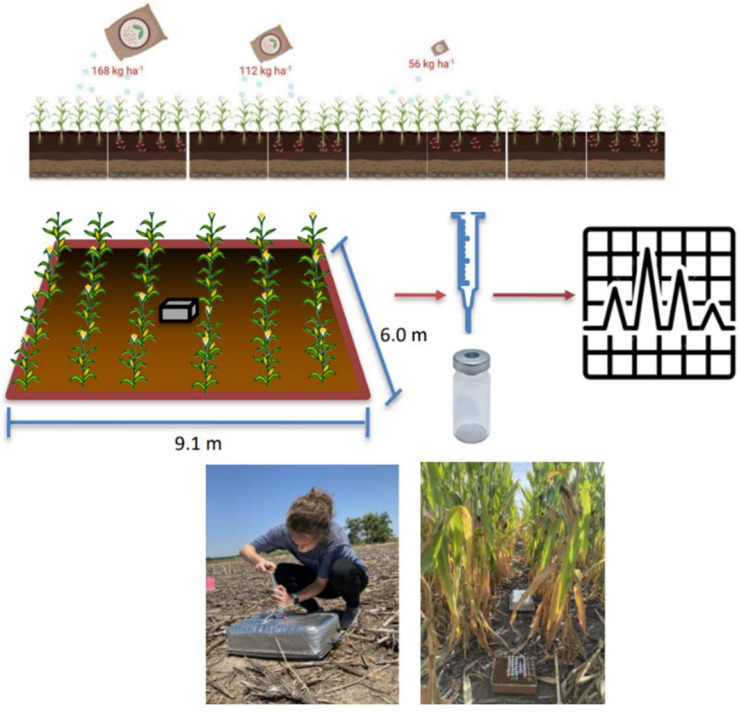


Comparison of nitrogen uptake in corn with and without Proven® at various N rates and growth stages in 2023

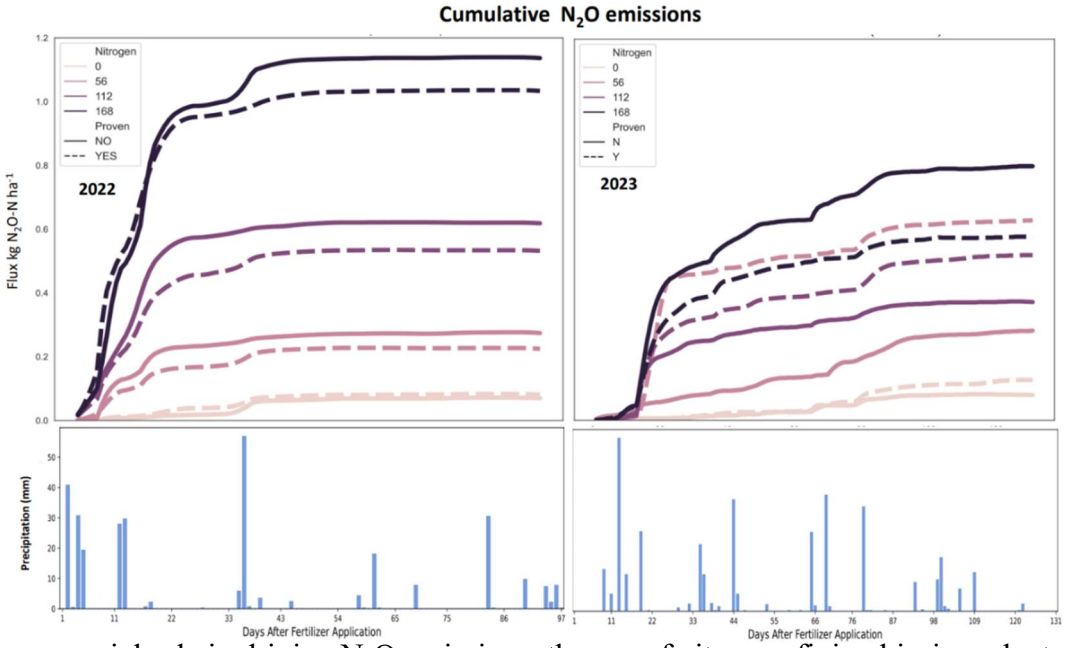


Effect of Proven® ('Y' for Proven®, 'N' for without) on average dry matter accumulation at VT growth stage (2023)

The environmental impact of nitrogen fertilizers, particularly through N_2O emissions, is a growing concern. N_2O, due to its potency as a greenhouse gas, plays a key role in climate change. The use of bio-inoculants like Proven® has the potential to reduce these emissions by decreasing the reliance on synthetic fertilizers. Although Proven® did not always boost yields, its ability to lower nitrous oxide emissions during early-season growth indicates its promise as an environmentally sustainable farming practice.



In our study, the bio-inoculant treatments consistently showed lower nitrous oxide (N_2O) emissions compared to untreated plots, although the reductions were not statistically significant. Across both years, N_2O emissions were influenced by the amount of nitrogen fertilizer applied, with higher nitrogen rates leading to increased emissions. However, the emission factors (EF%) for all treatments remained well below the IPCC's default value of 1%, indicating that the contribution of fertilizer-induced N_2O emissions in these systems was minimal. These results suggest that while nitrogen fertilizer rates



play a crucial role in driving N_2O emissions, the use of nitrogen-fixing bio-inoculants requires further research to optimize their effectiveness in reducing emissions and improving nitrogen use efficiency in corn cropping systems.

Future Directions

The use of nitrogen-fixing bio-inoculants, such as Proven®, represents a potential pathway toward more sustainable agricultural practices. By leveraging naturally occurring bacteria to provide nitrogen, farmers may be able to reduce their environmental footprint while maintaining crop productivity. Further research is needed to better understand the long-term effects of bio-inoculants on both crop yield and greenhouse gas emissions under varying conditions.

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