Nebraska Soybean Board
Year-End Research Findings Report

Please use this form to summarize the practical benefits of your research project and what has been accomplished. Your answers need to convey why the project is important and how the results impact soybean production.

Project Title: ***Resource Use Efficiency of High-Yield Soybean (#70326)***

Contractor & Principal Investigator: ***UNL–Department of Agronomy. PI: Patricio Grassini***

Please check/fill in appropriate box: ☐ ***Continuation research project***
☒ ***Year 2 of 3 research project (for example: Year 1 of 2)***

1. ***What was the focus of the research project or educational activity?***

The goal of this project is to quantify light capture, nitrogen uptake, and water use requirements of soybean in highly productive producer fields where crops yields approach their potential. The ultimate goal is to understand what is needed to achieve very high yields and use this information to fine tune current soybean management in order to bring current farm yields closer to the potential

2. ***What are the major findings of the research or educational activity?***

During the summer of 2016, experiments were successfully conducted at four producer irrigated fields, with previous history of high soybean yields (80+ bu/ac), located at Atkinson, Mead, Saronville, and Smithfield. Main difference from the experiment conducted in year 1 of the project (year 2015) was inclusion of a separate treatment that received periodic applications of nitrogen fertilizer to guarantee that crop nitrogen requirements for growth were fully met. The objective of including this treatment was to evaluate if high-yield soybean is limited, to any extent, by nitrogen supply. Just to give an idea of the magnitude of the work accomplished, our crew drove more than 20,000 miles during the summer months and collected more than 500 soy plant samples! We carefully recorded all management practices, including time of planting and irrigation events and application of fertilizer and pesticides. The four selected fields nicely portray the diversity of tillage methods across soybean producing regions in NE. Plant samples were collected EVERY WEEK and soil cores were taken at the beginning and end-of-season and also periodically during the growing season. These samples were collected and brought to our lab to determine growth stage, leaf area, total biomass, and partitioning of biomass into different plant organs (stems, leaves, seeds). Plant samples were dried, grinded, and sent to lab to determine nitrogen concentration. Equipment to measure light and water use were installed at each field and instruments were periodically checked by our crew and data downloaded. We have also installed a John Deere Field Connect (JDFC) equipment in each field and within the sampling site. The equipment and installation were provided at NO COST by John Deere. The JDFC includes a meteorological station that records incoming solar radiation, maximum and temperature, relative humidity, rainfall, and wind speed, and also a soil water sensor probe that measures water in the upper 4 ft of the soil. We have also measured contribution from biological N fixation by installing a small corn plot near our soybean experimental area. We have just finished collected the yield samples at the four sites. We still need to process the rest the data collected during the growing season but, a priori, it seems like the four producers have achieved very high yields (around 80 bu/ac and one achieved 92 bu/ac) and one of the key elements to reach such high yield level was to plant early to make sure that the crop canopy 'harvests' most of the sunshine by the time soybean approaches R3, which coincides to the time in which soybean starts to set pods and seeds. Good fertilizer and weed

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programs were key for developing a green healthy green canopy that converts the sunshine into crop biomass and yield. See appended TECHNICAL REPORT, summarizing the the experiments conducted during the second year of the project.

3. ***Briefly summarize, in lay terms, the impact your findings have had, or will have, on improving the productivity of soybeans.***

This is the very first explicit effort to understand what is needed to produce 80+ bu/ac soybean routinely in producer fields. Likewise, this is the first study to evaluate the degree of limitation by nitrogen supply in environments that allow expression of soybean yield potential (80+ bu/ac). We believe that results from this project will help fine tune current management of soybean fields in order to bring producer soybean yields closer to their potential, by narrowing the existing yield gap. This is the second year of the project, and we are not done in processing the samples and data, but, a priori, it look like, similarly to the first year of the project (2015), the yield obtained at the four producer fields in 2016 were very high (around 80 bu/ac, with on them reaching 92 bu/ac) and we are excited to understand what combination of resources (light, water, nitrogen) and management (planting, density, MG, fertilizer) allowed these fields to achieve such high yield level. We also want to highlight that the four producers have told us how important is to have on-farm projects like ours in order to help NE soybean producers to sustain future soybean yield gains through better agronomic management.

4. ***Describe how your findings have been distributed to (a) farmers and (b) public researchers. List specific publications, websites, press releases. etc.***

We met with the four producers during Jan-Feb 2016 to share the results from Year 1 experiments and discuss 2016 experiments. Dr Patricio Grassini (Project PI) gave presentations about results from this project at the 2016 winter UNL Crop Production Clinics at 8 locations in NE (total # of attendants: 500). Patricio also presented these results at one extension event organized at Bertrand NE (total attendants #: 120). Nicolas Cafaro (MS student working on this project) also presented the results at the NSB meeting at Lincoln NE in March 2016. We have published a UNL Extension Circular that includes results derived from this study: Grassini P, Rees J, Specht, J, Cafaro La Menza N 2016. What does it take to produce 80 bu/ac soybean? Extension Circular 3000. University of Nebraska-Lincoln. URL: http://extensionpubs.unl.edu/publication/9000017620473/what-does-it-take-to-produce-80buac-soybean/

5. ***Did the checkoff funding for your project leverage any additional state or Federal funding? Please list sources and dollars approved.***

The funding provided us support and incentive to write another big 10-state 3-year proposal on soybean benchmarking, which was funded by the North Central Soybean Research Program (NCSRP) at a level of 1.5 million (total for the 3 years). Patricio Grassini is the PI of the funded NCSRP project.

SEE APPENDED TECHNICAL REPORT.

Resource-use efficiency of high-yield soybean in Nebraska

Year 2 Technical Report

Patricio Grassini (PI), Tim Arkebauer, John Lindquist, George Graef

Department of Agronomy & Horticulture

University of Nebraska-Lincoln

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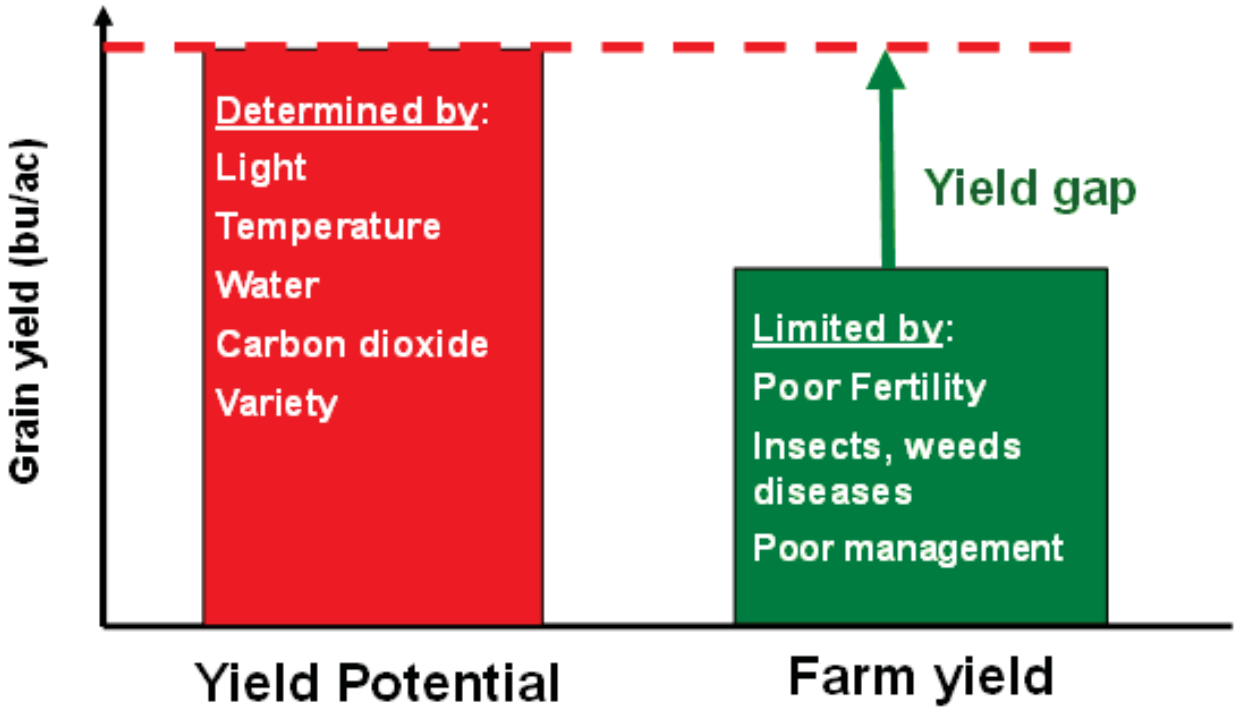
Framework: yield potential & yield gap



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Objective

The specific goal of this project is to quantify light capture, nitrogen uptake, and water use of soybean in highly productive producer fields where crop yields approach their potential

The ultimate goal is to understand what is needed to achieve very high yields and use this information to fine tune current soybean management in order to bring current farm yields closer to the potential

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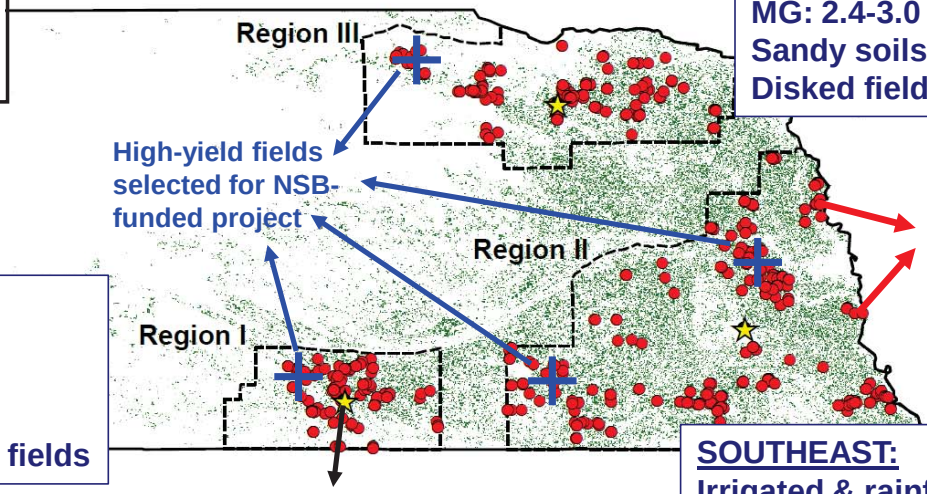
Selected 2016 fields for NSB project

Data from 500+ soybean fields in NE planted in 2010, 2011, and 2012 (collected through a previous NSB-funded project led by Drs Specht & Cassman) were used as basis for selecting the high-yield fields for the present NSB project

Soybean harvested area is indicated in green



NORTHEAST:
Irrigated & rainfed
MG: 2.4-3.0
Sandy soils
Disked fields

High-yield fields selected for NSB-funded project

Red dots indicate location of surveyed fields

SOUTH-CENTRAL:
Only irrigated
MG: 2.7-3.0
Silt loam soils
No- or reduced-tilled fields

Stars indicate location of a representative weather station in each region

SOUTHEAST:
Irrigated & rainfed
MG: 3.0-3.5
Silt loam & silty clay loam soils
No- or reduced-tilled fields

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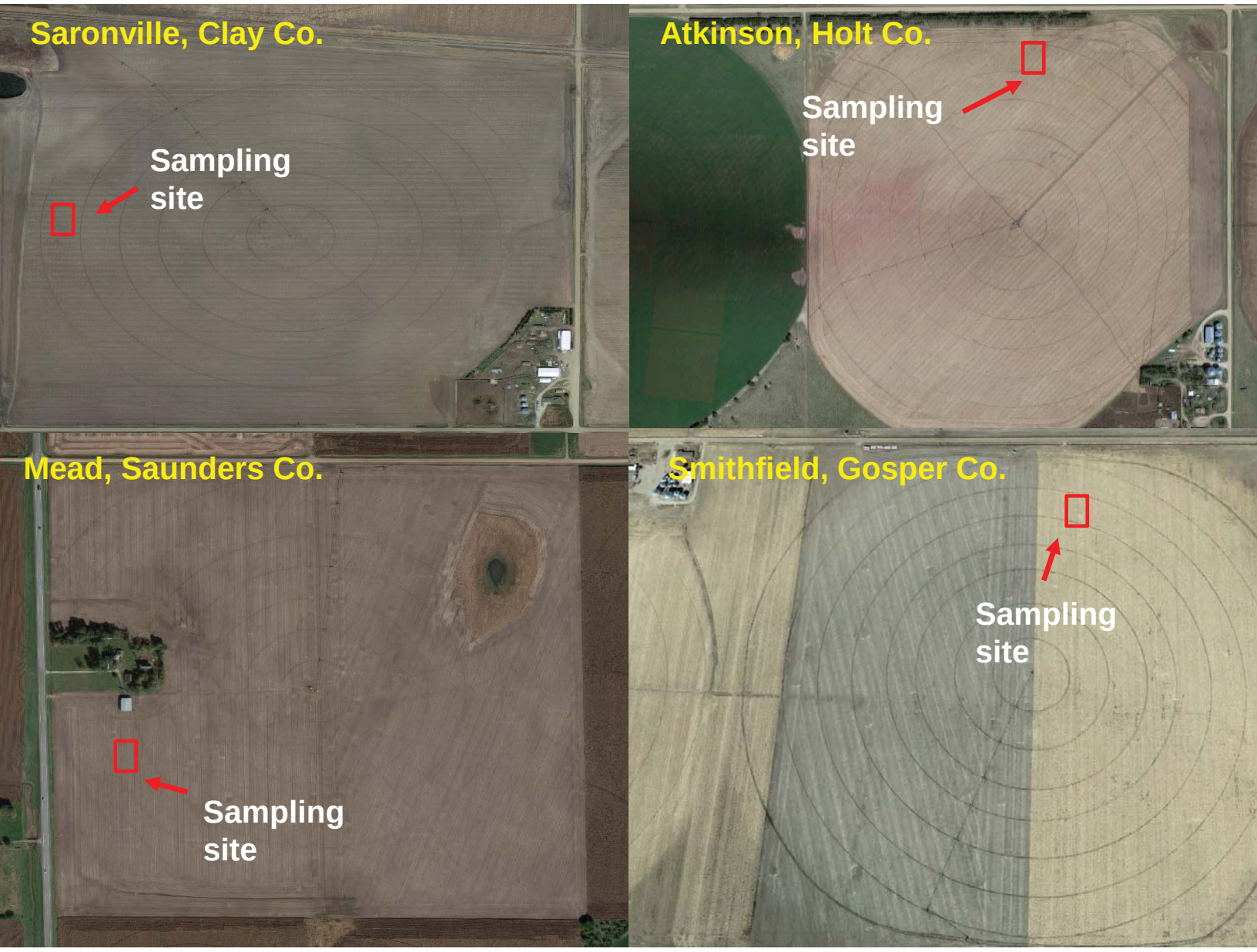
Saronville, Clay Co.
Sampling site
Atkinson, Holt Co.
Sampling site
Mead, Saunders Co.
Sampling site
Smithfield, Gosper Co.
Sampling site

2016 crop management

Location	Planting date	Variety maturity group	Seeding rate (seeds ac^{-1})	Tillage	Fertilizer (lb ac^{-1})	Fungicide/ Insecticide at R3?
Saronville (Clay Co)	April 26	2.4	140K 30''	Disk	N(15)P(31) S(9) Zn(1)	YES
Atkinson (Holt Co)	April 25	2.7	160K 30''	Disk	N(18) P(20) K(45) Ca(55) Mg(7) S(15) Zn(1.5)	YES
Mead (Saunders Co)	May 8	2.7	140K 30''	Strip-till	N(12) P(18) S(10) Zn(1)	YES
Smithfield (Gosper Co)	May 13	2.4	180K 30''	No-till	P(34) S(1)	YES

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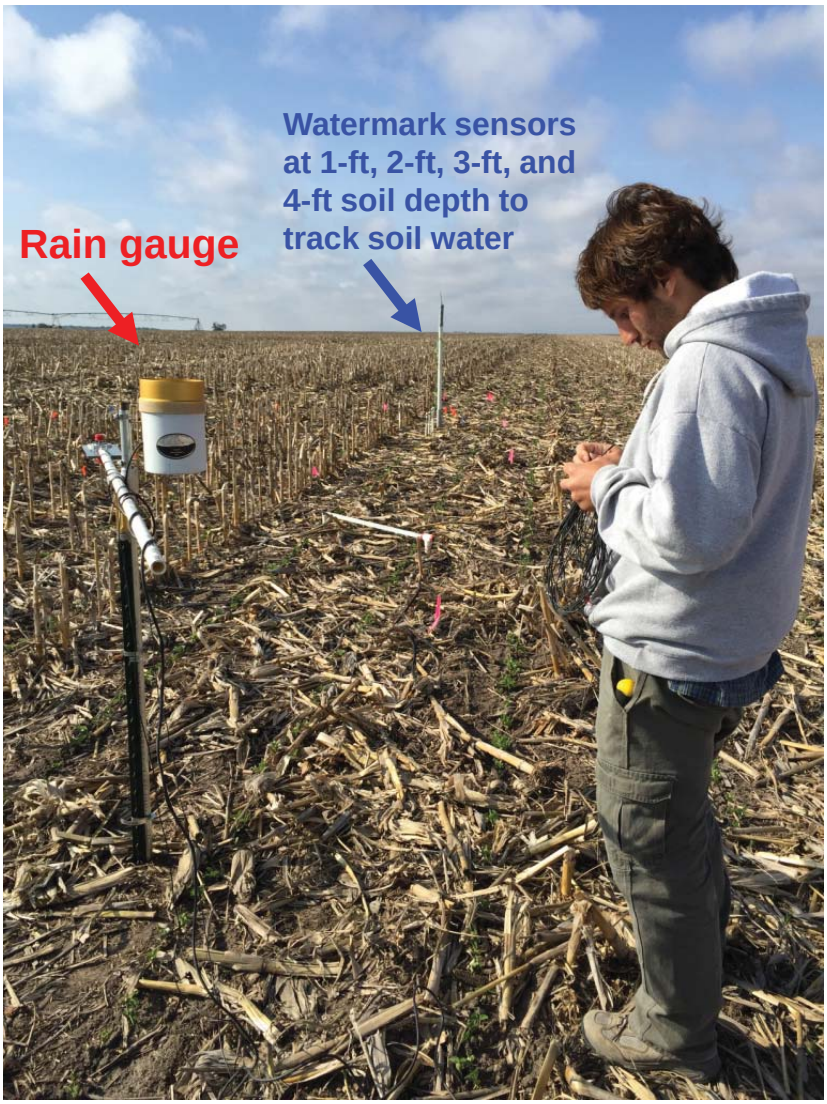
How do fields look like by mid-July?

Saronville, Clay Co.

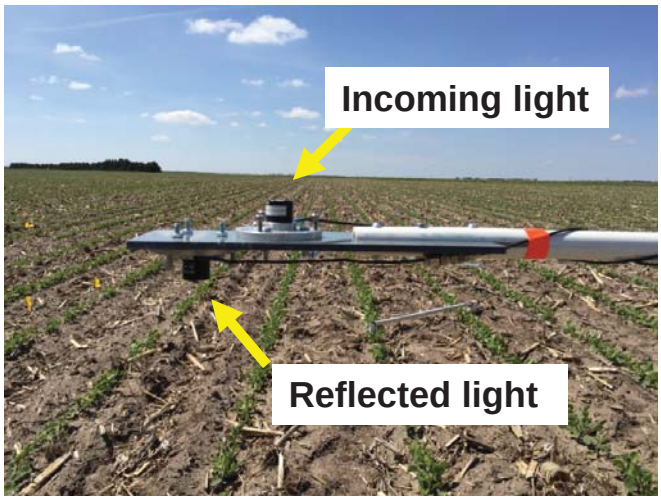
Atkinson, Holt Co.

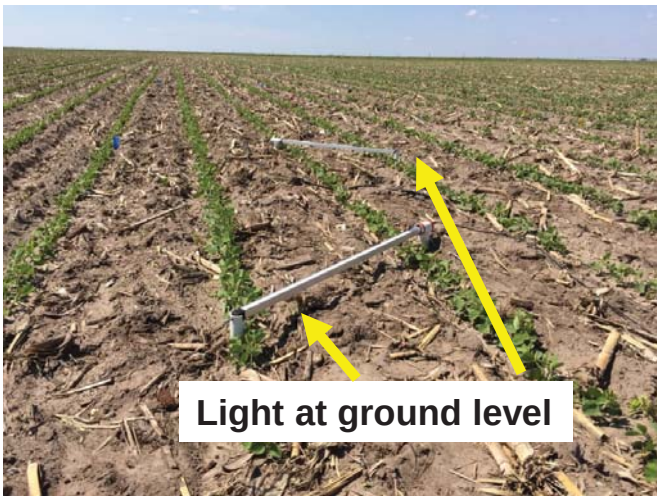
Mead, Saunders Co.

Smithfield, Gosper Co.



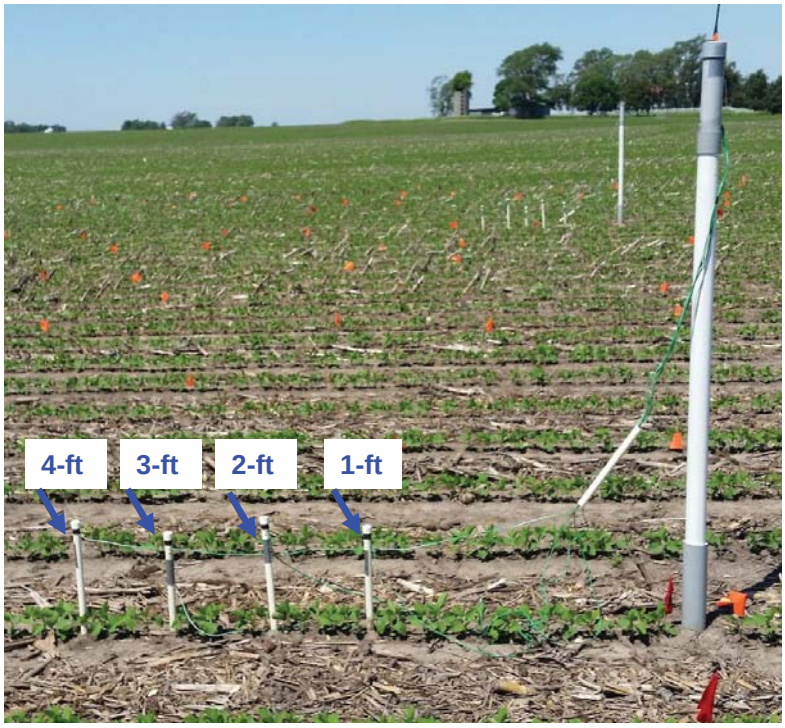
Light sensors:





Watermark sensors

Example on one set of WM sensors (with 4 sensors each, at different soil depths). Four sets were installed in each of the 4 producer fields.



John Deere ® Field Connect equipment:

Soil properties at 2016 planting

Field	Depth (ft)	Soil texture	Organic Matter (%)	Nitrogen (lbs N/ac)	Phosphorus (ppm)
Saronville	1	Silt Loam	3.1	28	27
	2	Silty Clay Loam	2.4	21	10
	3	Silty Clay Loam	2.0	14	14
	4	Silty Clay Loam	1.7	13	15
Atkinson	1	Sandy Loam	1.6	14	53
	2	Sandy Loam	1.5	20	22
	3	Sandy Loam	1.0	20	8
	4	Loamy Sand	0.6	22	8
Mead	1	Silty clay loam	3.4	16	14
	2	Silty clay loam	2.6	16	7
	3	Silty clay loam	1.9	18	10
	4	Silty clay loam	1.5	15	9
Smithfield	1	Clay Loam	2.8	19	24
	2	Silt Loam	1.7	13	7
	3	Silt Loam	1.3	13	9
	4	Silt Loam	1.3	14	9

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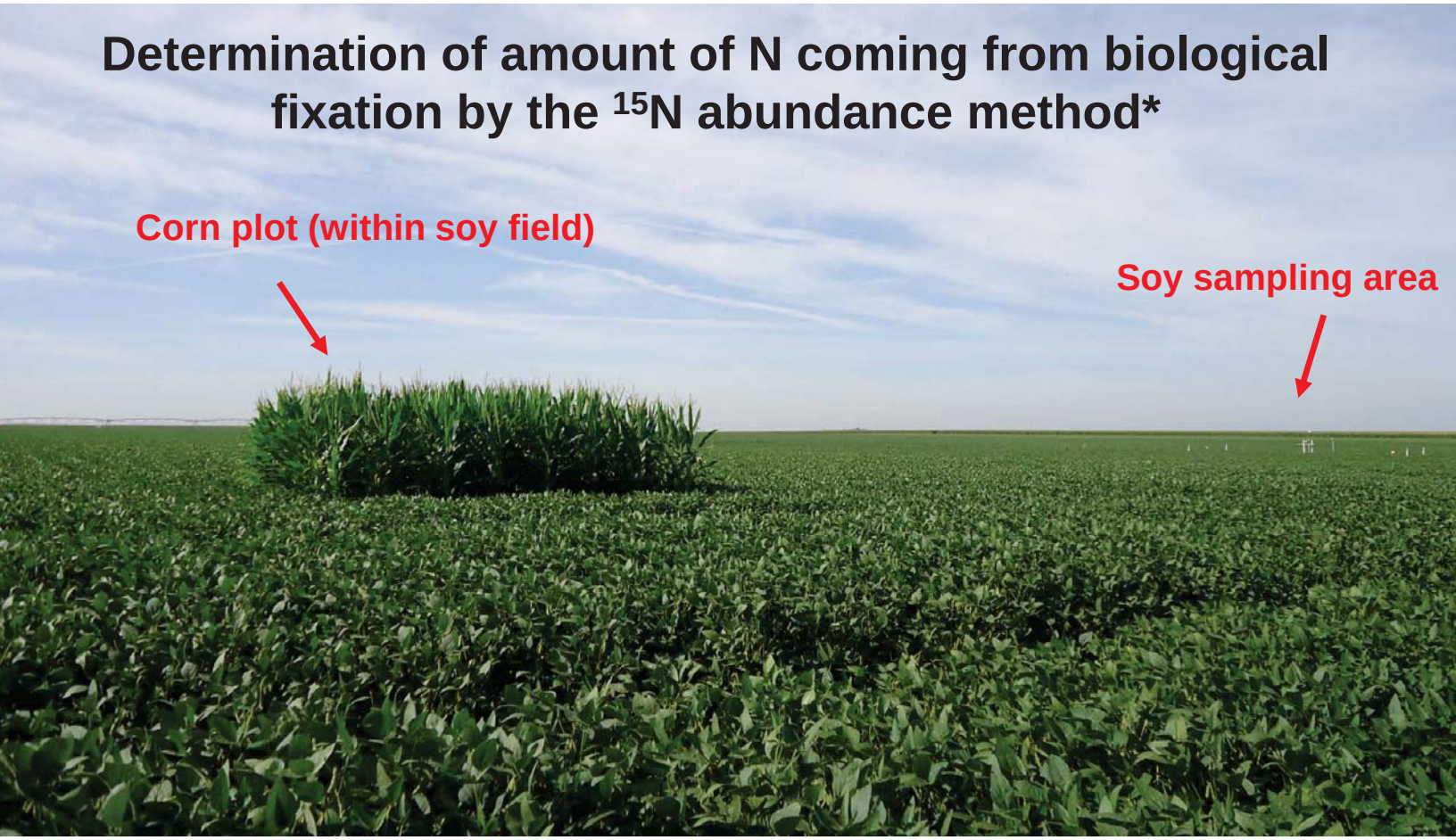
Determination of amount of N coming from biological fixation by the ^{15}N abundance method*



*It relies on the phenomenon that soil mineral N is naturally enriched in the heavy N isotope (^{15}N) relative to atmospheric N. Hence, a non-N-fixing crop (corn) growing solely on soil mineral N is likely to have greater ^{15}N abundance relative to N-fixing crops (soybean). Relative reliance of soybean on biological N fixation can then be calculated by comparing the ^{15}N composition of soybean to the ^{15}N composition of corn.

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Summary

We have just finished conducting experiments in 4 high-yield NE producer fields and collecting data on light, water and N capture. We have also measured contribution from biological N fixation.

In 2016, we have also included a treatment where we applied N fertilizer to evaluate the degree of limitation by N in high-yield soybean crops

We have presented results at the Winter UNL Crop Production Clinics at 8 locations and one field extension event at Bertrand NE (# attendants: 620)

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Investigators:

Tim Arkebauer
John Lindquist
George Graef
Jim Specht
Trenton Franz

Technical assistance:

Dave Scoby
Mike Livingston
Aaron Hoagland

Students:

Nicolas Cafaro
Mariano Hernandez
Agustina Diale
Fatima Tenorio
Justin Gibson

Producers:

Ray Kucira
Bryan Rentschler
Lyle Nunnenkamp
Dennis Gengenbach

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Thanks!

Questions?

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