NDSU NORTH DAKOTA STATE UNIVERSITY

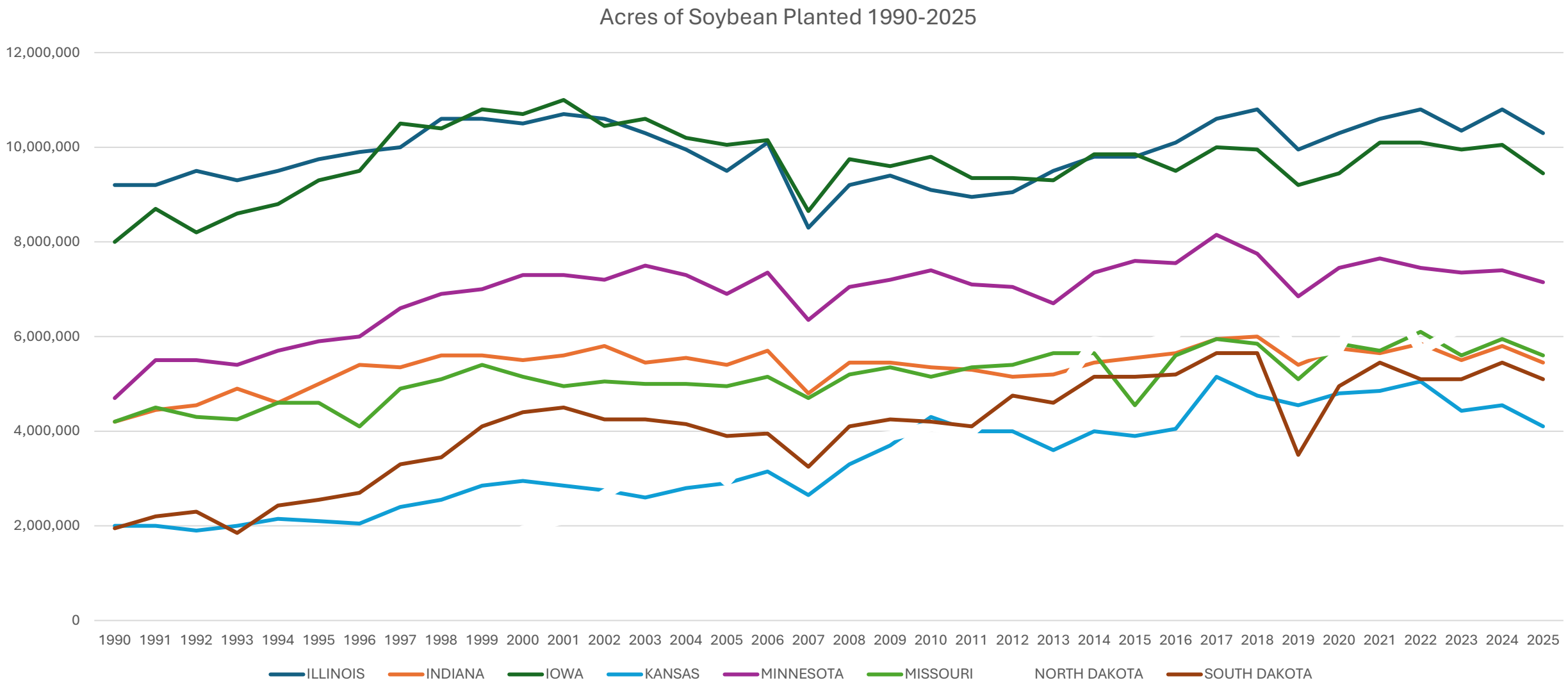
STUDENT FOCUSED • LAND GRANT • RESEARCH UNIVERSITY

Breeding For Enhanced N Fixation Under Low Water Conditions To Protect Soybean Yields

Carrie Dottey
Assistant Professor
North Dakota State University

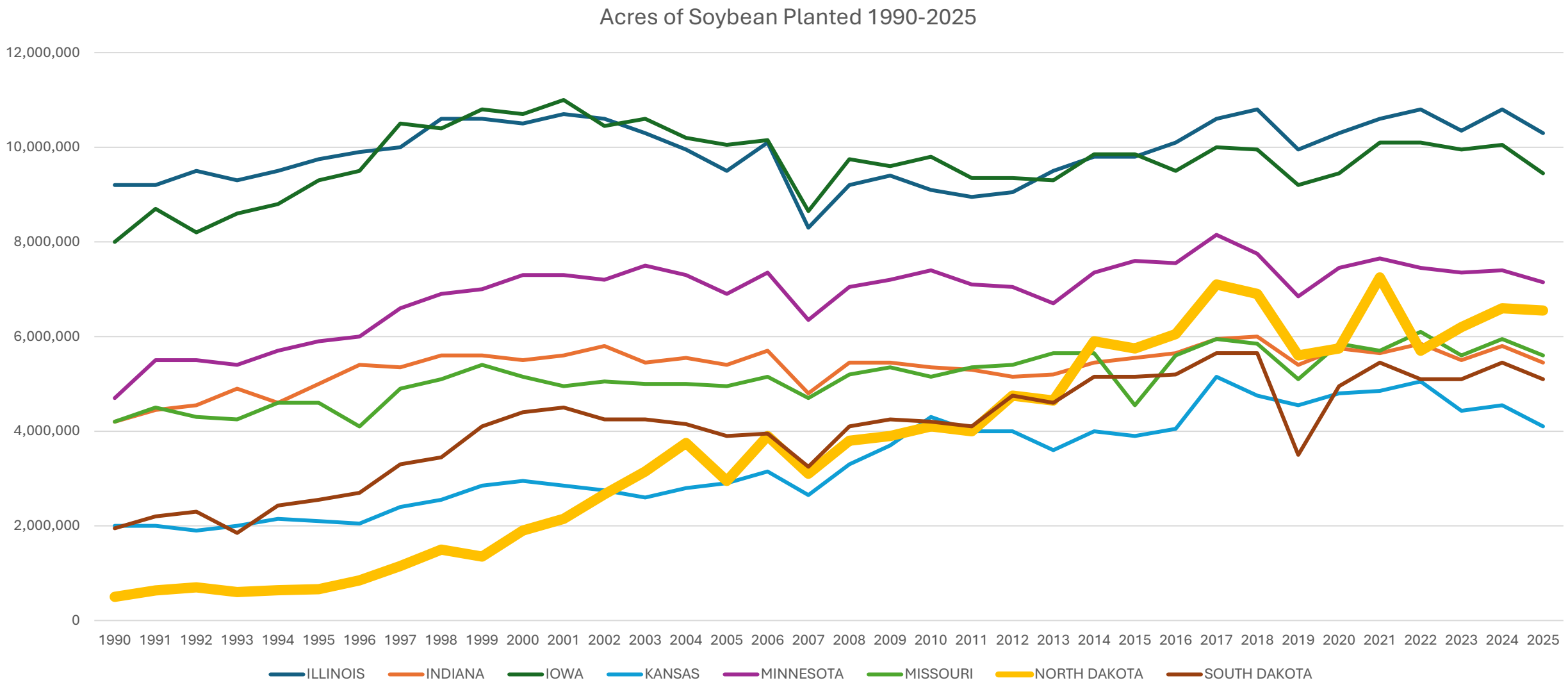
Source: USDA NASS

Soybean production in Midwest: Acres planted from 1990-2025



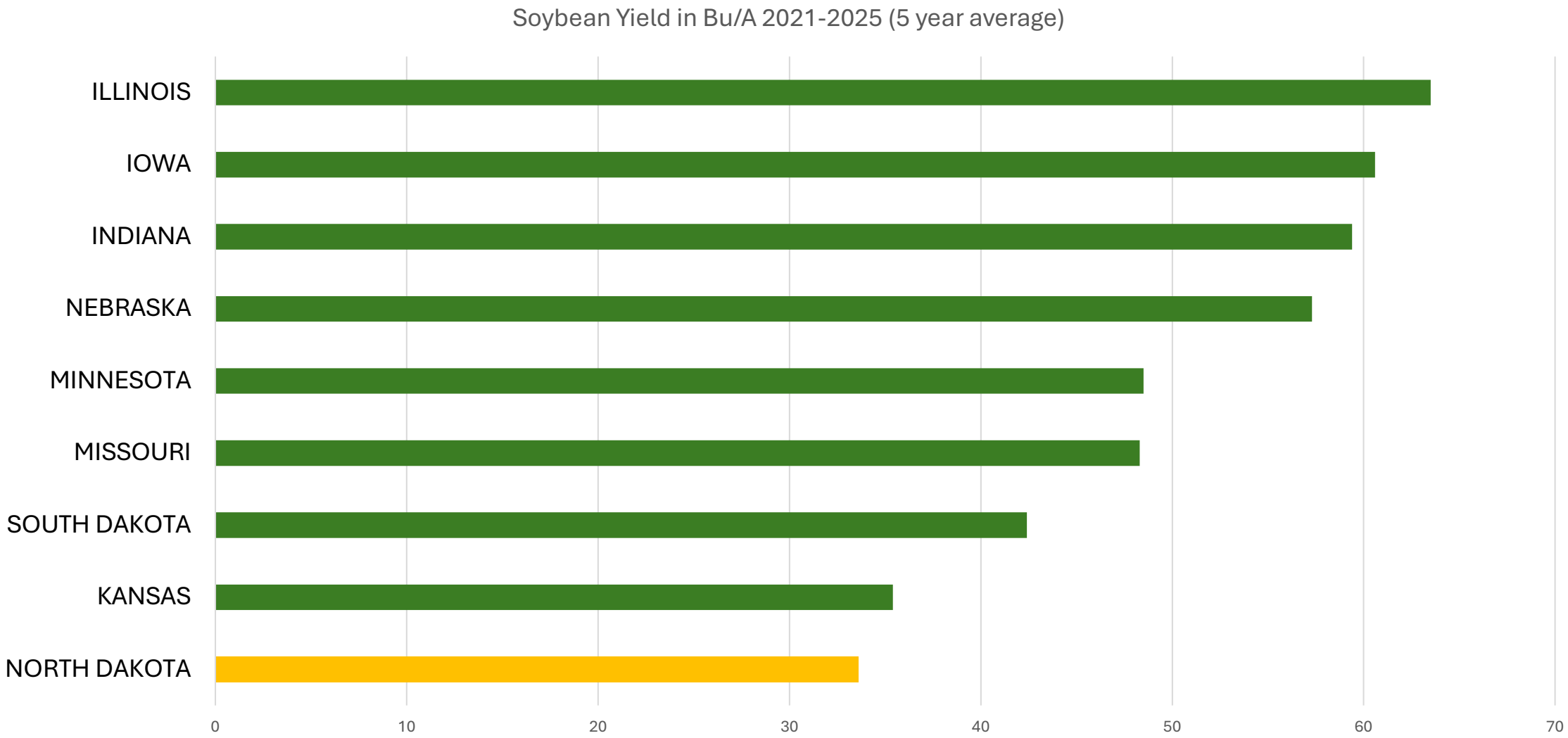
Source: USDA NASS

Soybean production in Midwest: Acres planted from 1990-2025

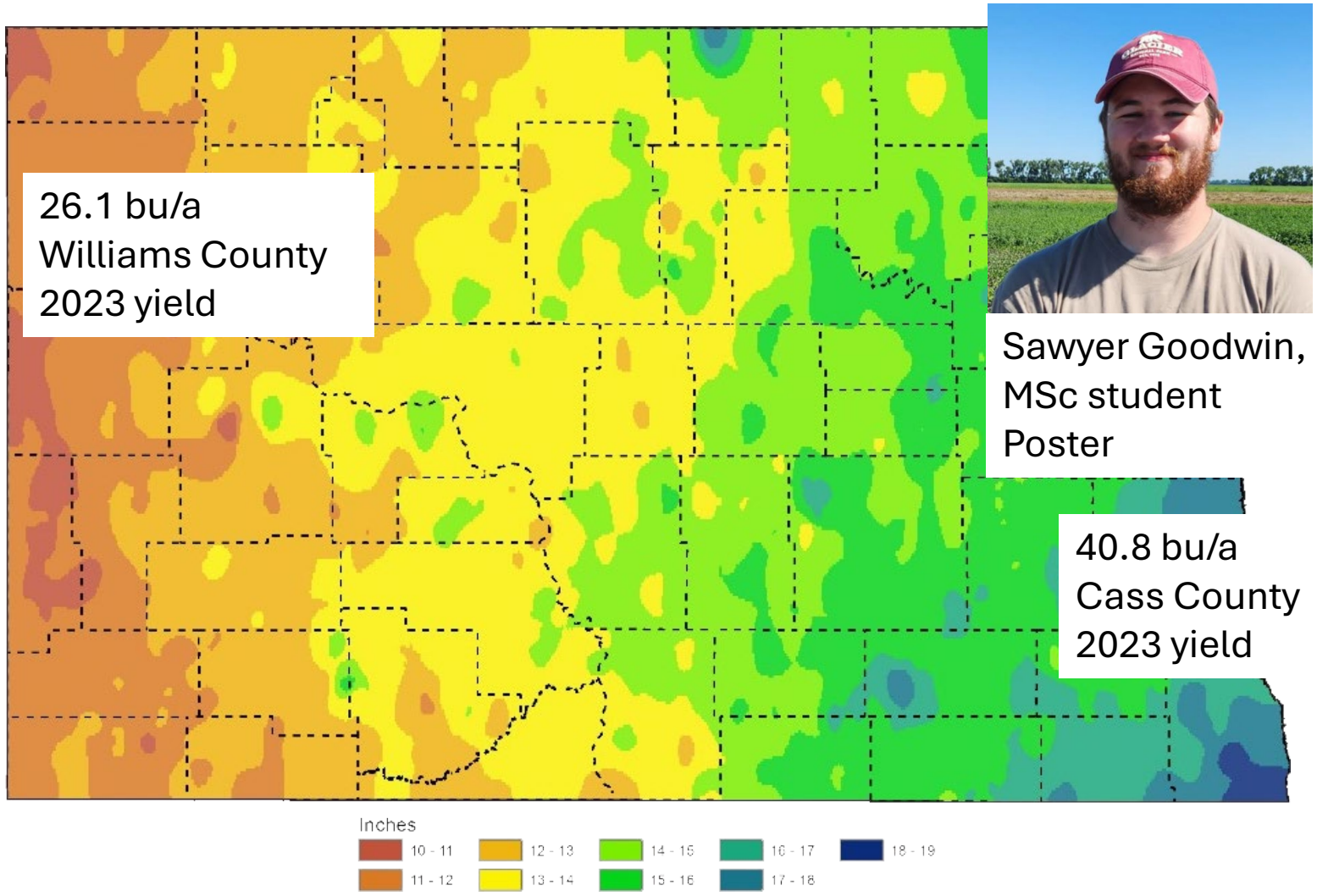


Source: USDA NASS

5 year soybean yield average in Midwest



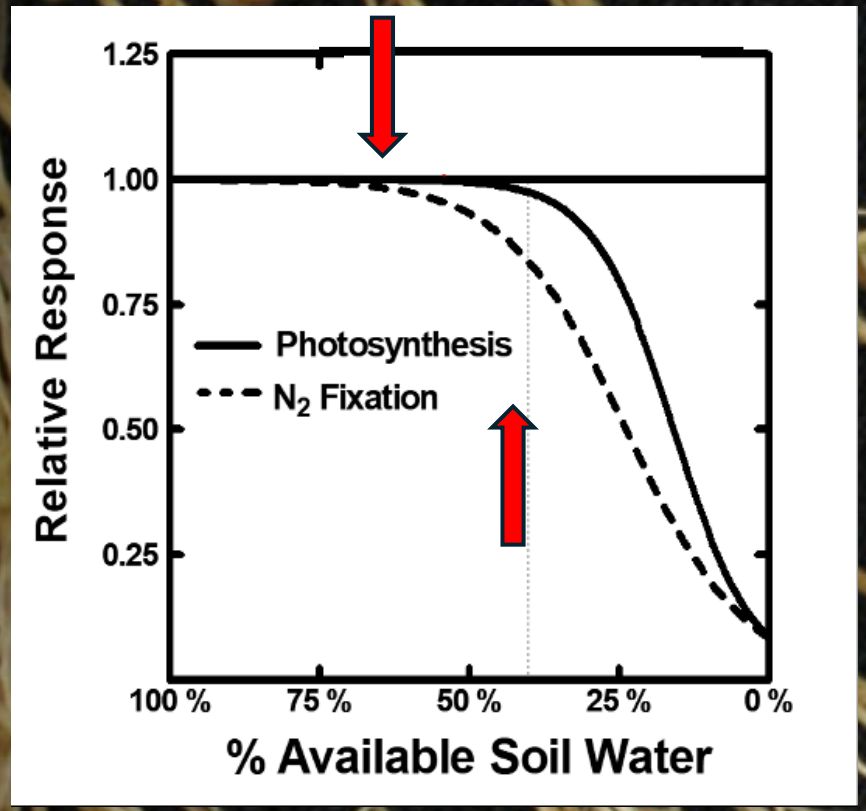
Precipitation in North Dakota April-Sept 1980-2010



Sawyer Goodwin,
MSc student
Poster

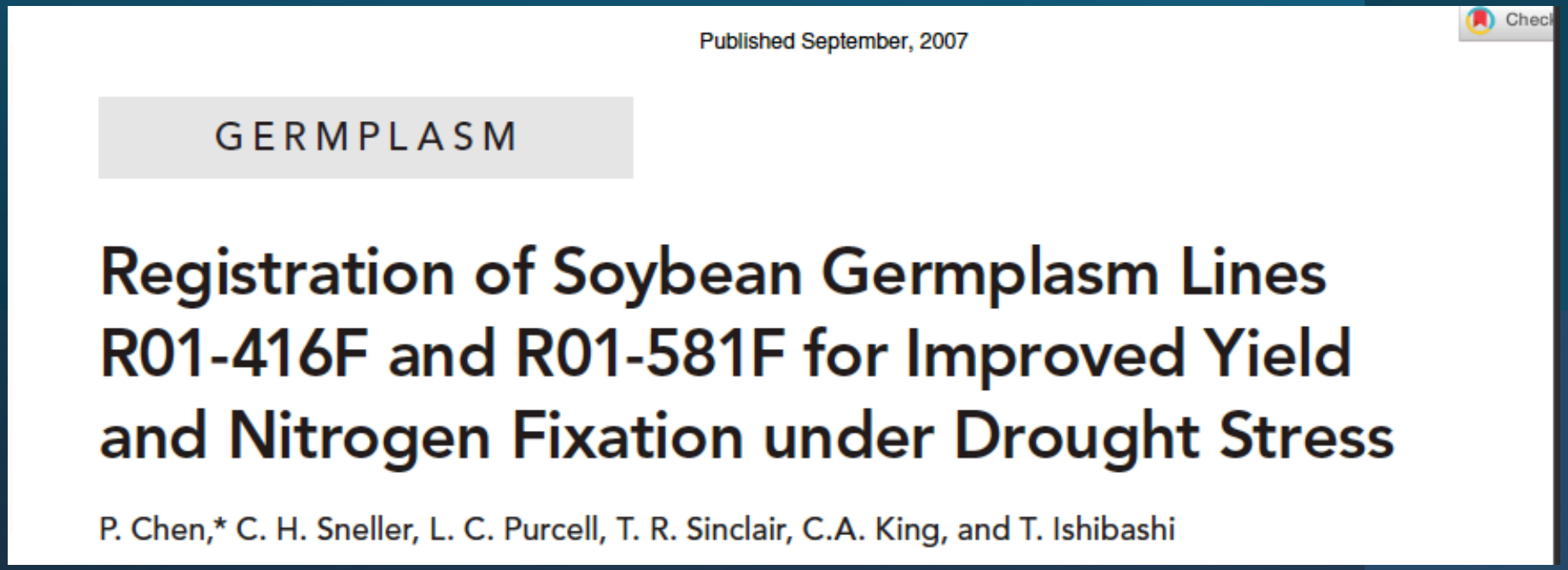
Source: ND Game and Fish. Data from State Water Commission.

Sustained symbiotic nitrogen fixation trait (SSNF)



- Genetic mechanism that can sustain *Bradyrhizobium* symbiotic nitrogen fixation during times of water stress
- Identified in ‘Jackson’ (MG VII)
- Breeding population developed by crossing with non SSNF line ‘KS4895’

Equations by Sinclair 1986, Figure by Heatherly and Ray 2007, Updated by Fritschi 2025



Published September, 2007

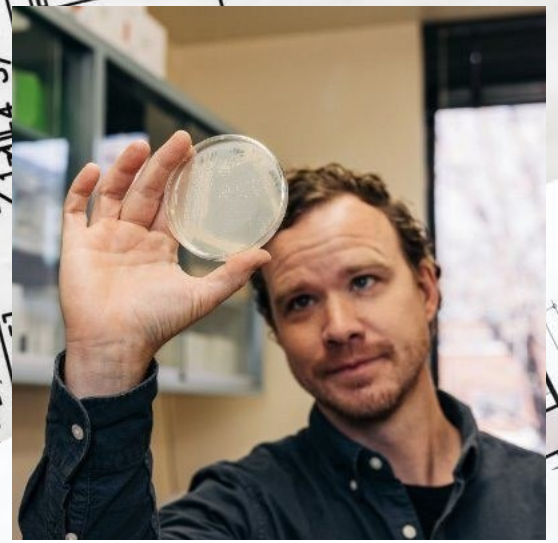
GERMPLASM

Registration of Soybean Germplasm Lines R01-416F and R01-581F for Improved Yield and Nitrogen Fixation under Drought Stress

P. Chen,* C. H. Sneller, L. C. Purcell, T. R. Sinclair, C.A. King, and T. Ishibashi

- Two lines released as varieties
- 20 sites of irrigated vs dryland experiments
  - Irrigated: Both varieties exceed check yield by 1-14%
  - Dryland: Yield loss (compared to irrigated) was 37-42% and non SSNF check loss was 44%
- Greenhouse ARA assay: soil moisture % at which N fixation declined was 6-22% less than KS4895

The Plan:



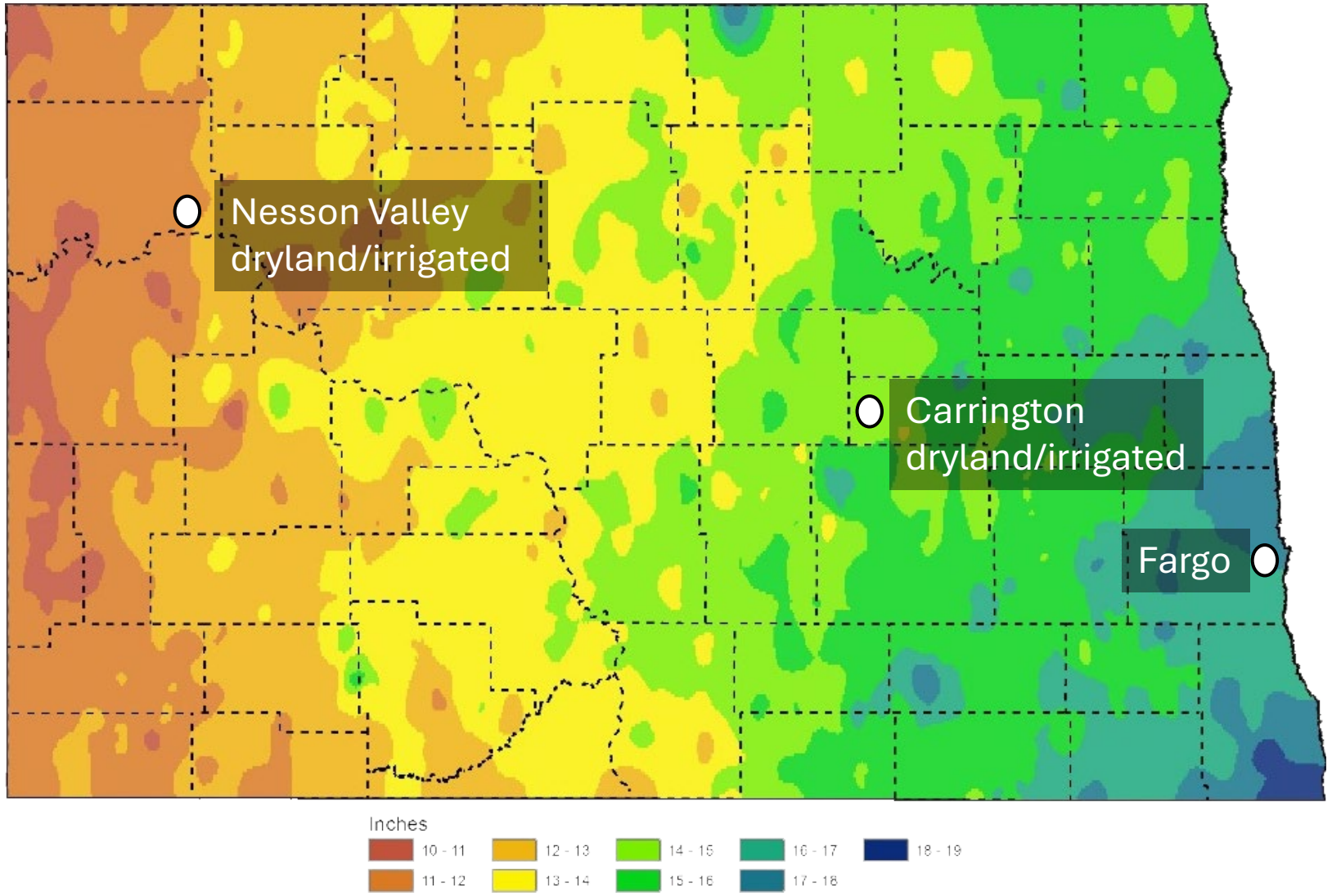
Barney Geddes
Microbiologist
North Dakota State University

Felix Fritschi
Physiologist
University of Missouri

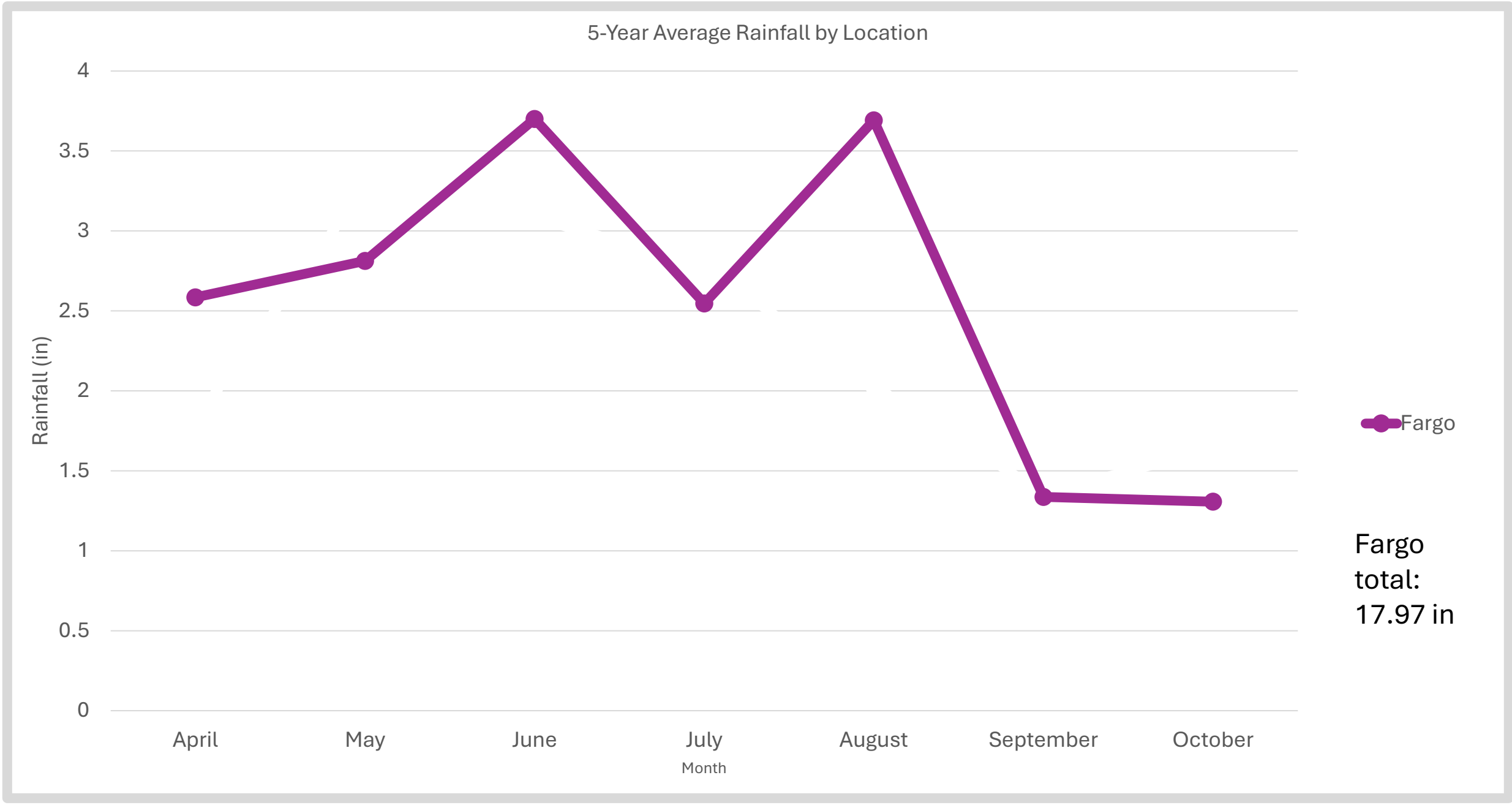
- Assemble a team
- Acquire breeding rights to AR lines
- Initiate breeding
- Simultaneously optimize phenotyping protocol for SSNF trait
- Conduct field trials to determine usefulness of trait in North Dakota

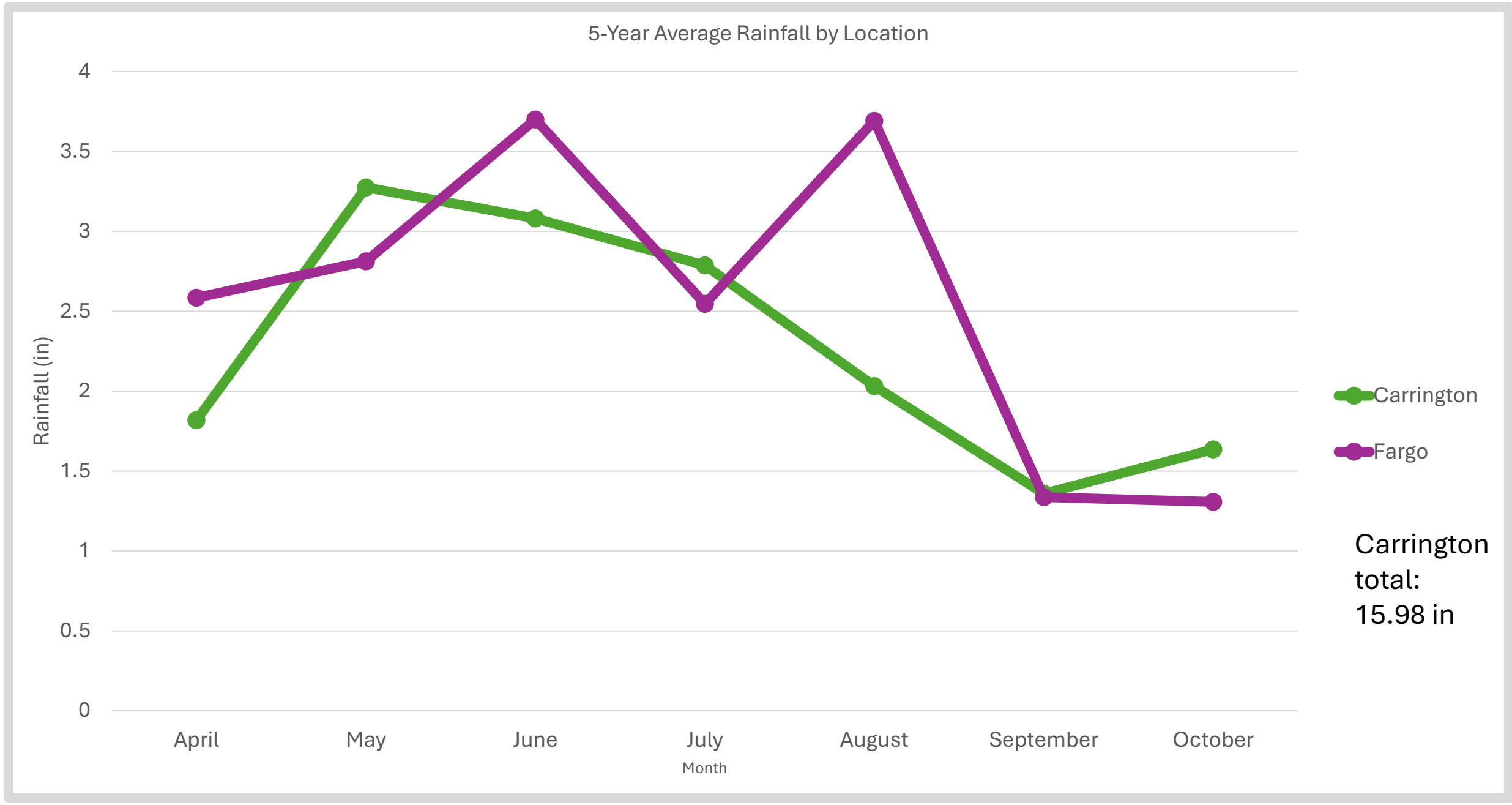
Yield trials 2026

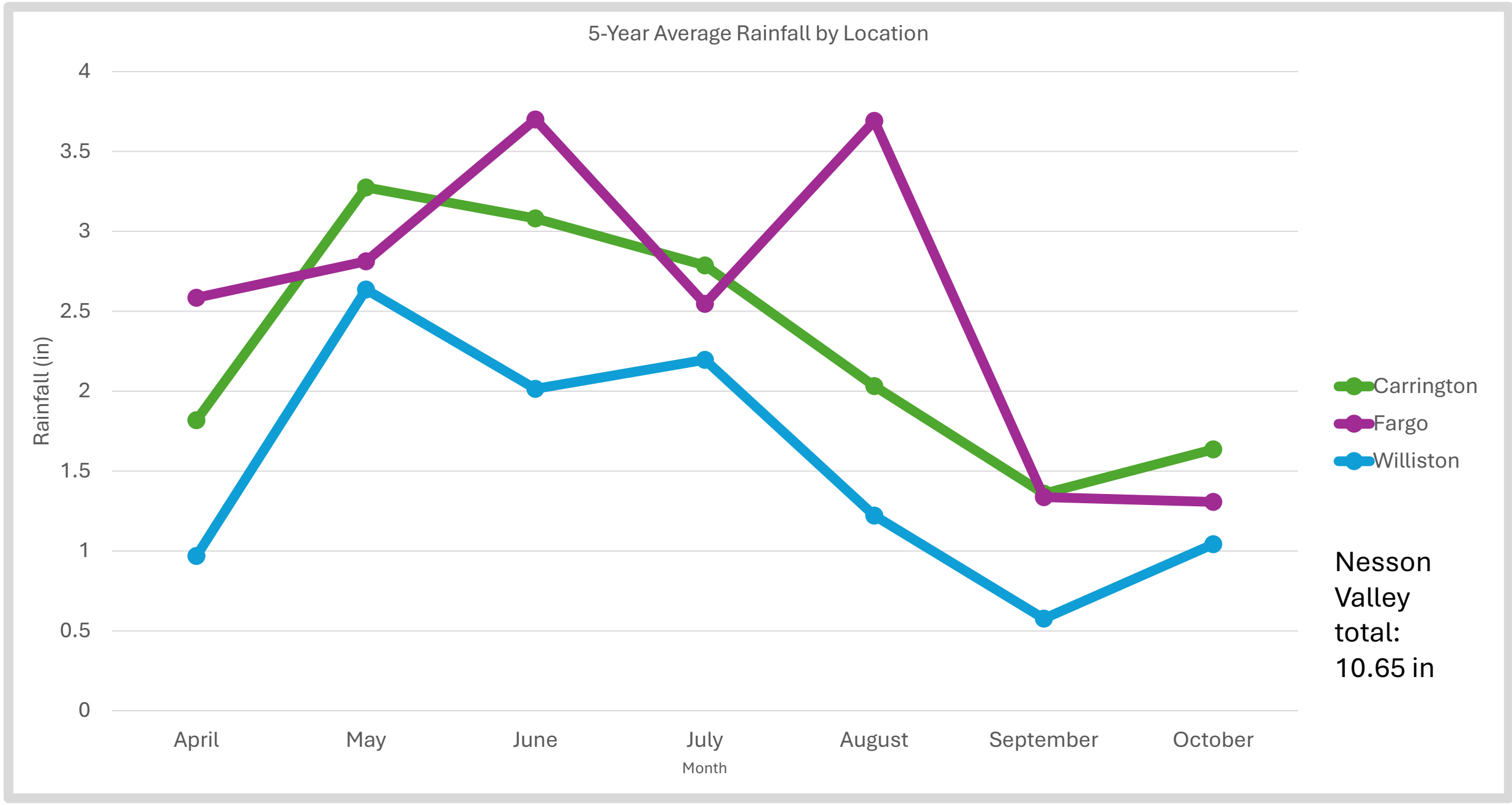
3 locations



Source: ND Game and Fish. Data from State Water Commission.


5-Year Average Rainfall by Location
Rainfall (in)
4
3.5
3
2.5
2
1.5
1
0.5
0
April
May
June
July
August
September
October
Month
Fargo
Fargo total: 17.97 in


5-Year Average Rainfall by Location
Rainfall (in)
4
3.5
3
2.5
2
1.5
1
0.5
0
April
May
June
July
August
September
October
Month
Carrington
Fargo
Carrington total: 15.98 in


5-Year Average Rainfall by Location
Rainfall (in)
4
3.5
3
2.5
2
1.5
1
0.5
0
April
May
June
July
August
September
October
Month
Carrington
Fargo
Williston
Nesson Valley total: 10.65 in

Breeding Pla

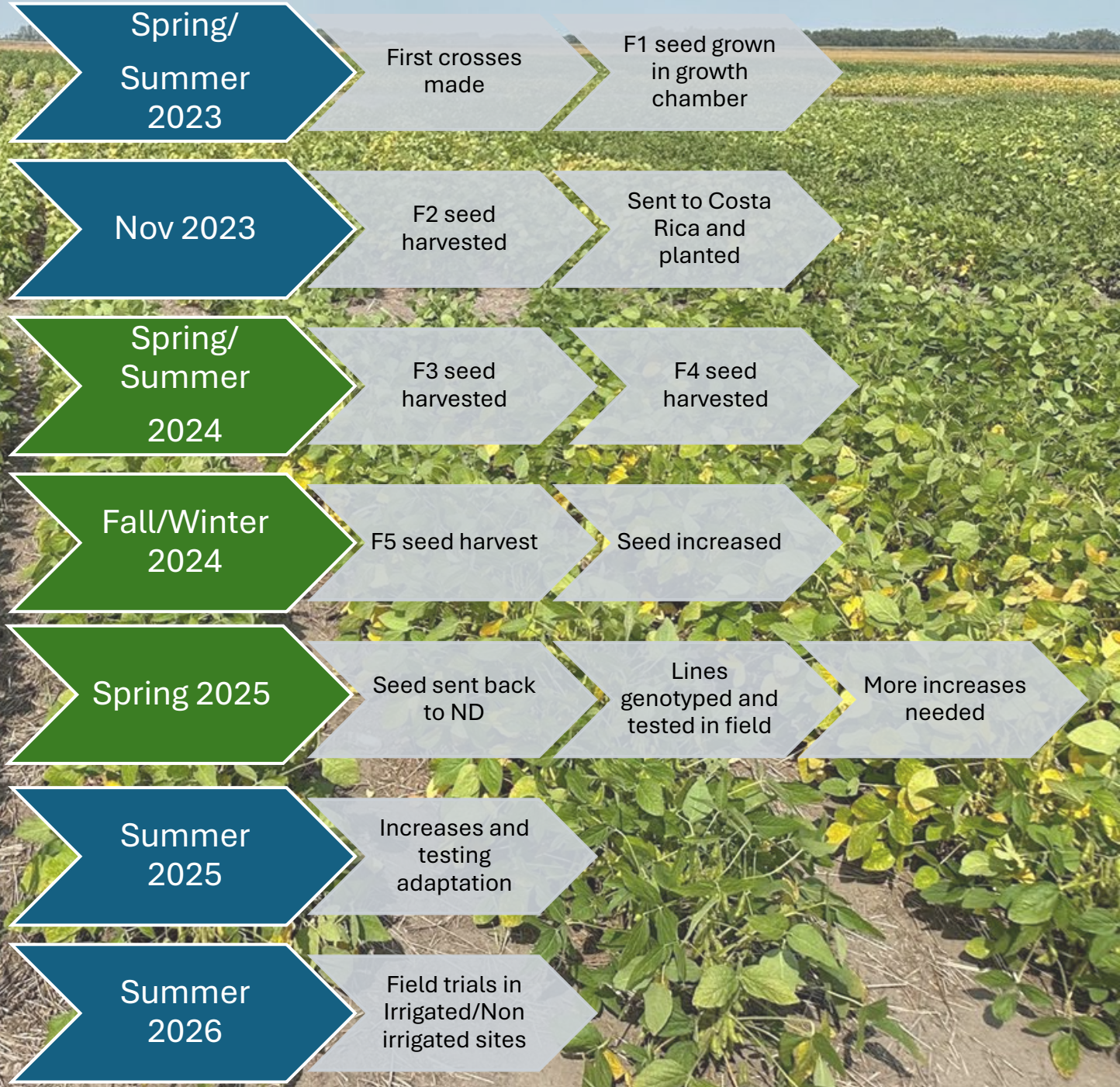
Challenge: MG V to MG 0

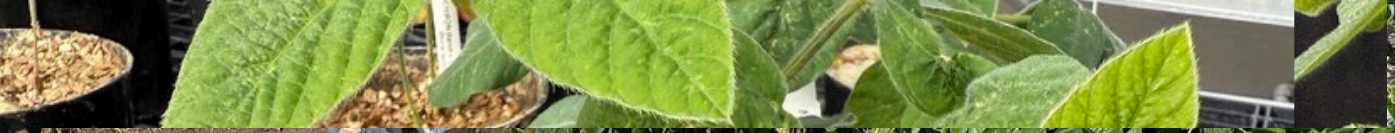
Timeline for variety creation

- **Typically 8-10 years**
- ~~4 years to advance new cross to allow for testing~~
- 4 years of yield trials
- 1-2 years to increase seed to sell

Developed 3 populations of 186 lines total

- 35 adapted to North Dakota





Williston 2023
Field trial with controls

Determine biological nitrogen fixing ability due to *Bradyrhizobium*

-Fixed atmospheric nitrogen only,

Soil nitrogen not included

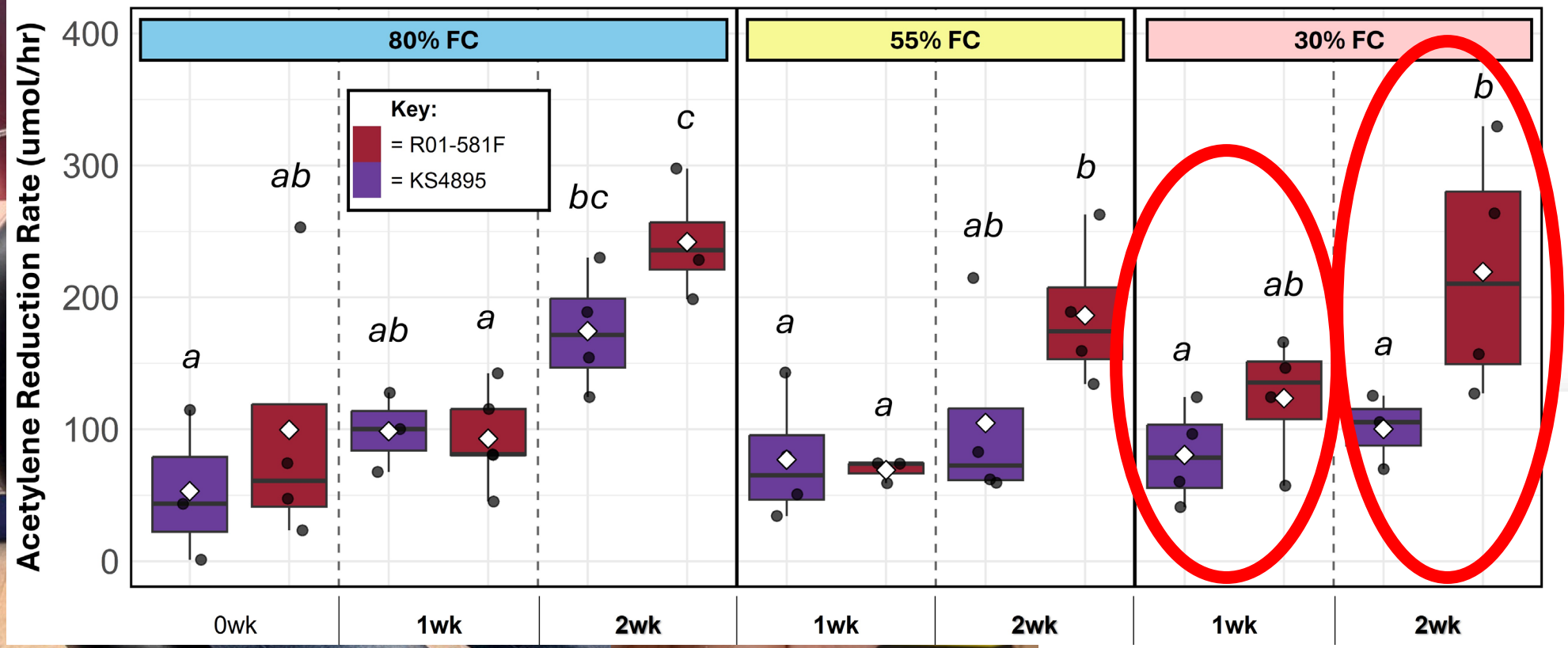
Postdoc Dr. Cullen Dixon

has poster

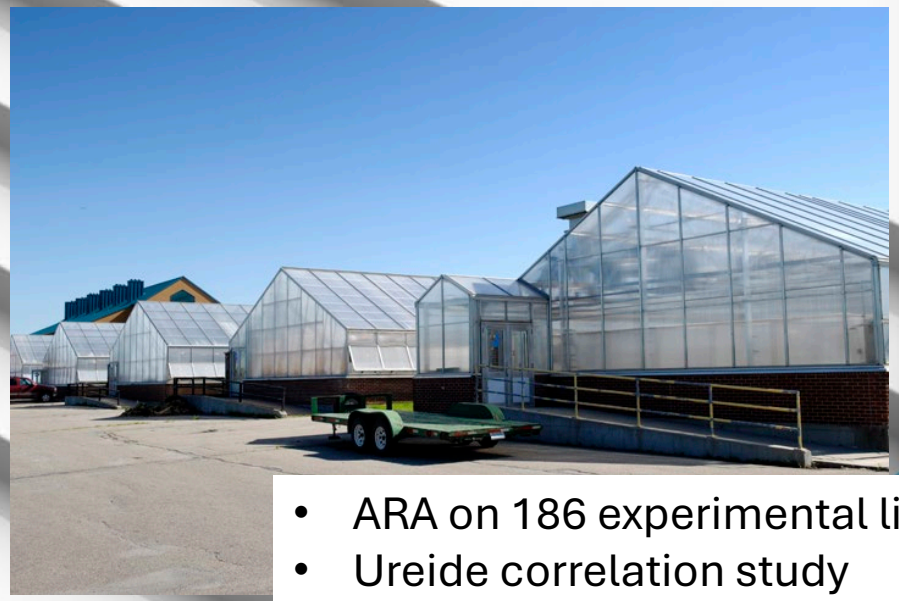
Started in July 2025 to conduct phenotyping

Actively working on ARA and Ureide analysis

Fig 4. **Rate of Acetylene Reduction Across Genotypes, Drought Intensities, and Lengths**

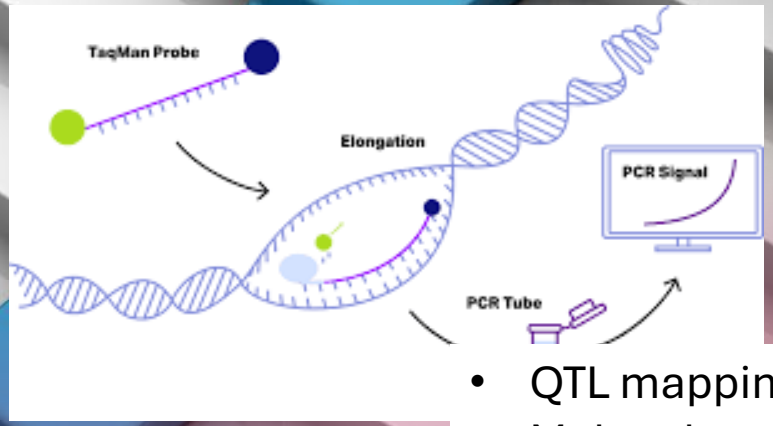


Next Steps:



- ARA on 186 experimental lines
- Ureide correlation study
- High throughput ureide assay

- Irrigated and dryland yield trials
- Determine usefulness of trait in different water conditions



- QTL mapping
- Molecular marker development


UNITED SOYBEAN BOARD™
NDSU
ND SOYBEAN COUNCIL
chicco