Alfalfa to get back into planetary boundaries

2025 world alfalfa congress
FRANCE REIMS-CHÂLONS

New alfalfa based cropping systems

Liu, N. & Cree K.

Parallel session 3

FROM 03 › TO 06 nov. 2025

Alfalfa to get back into planetary boundaries

2025 world alfalfa congress
FRANCE REIMS-CHÂLONS

Alfalfa Established in Intercropping with Sunflower Allocates Fixed Nitrogen to the Crop

Marisol Berti[1]*, Md S. Islam[1], F. Omeye[1], and C. Graham[2]

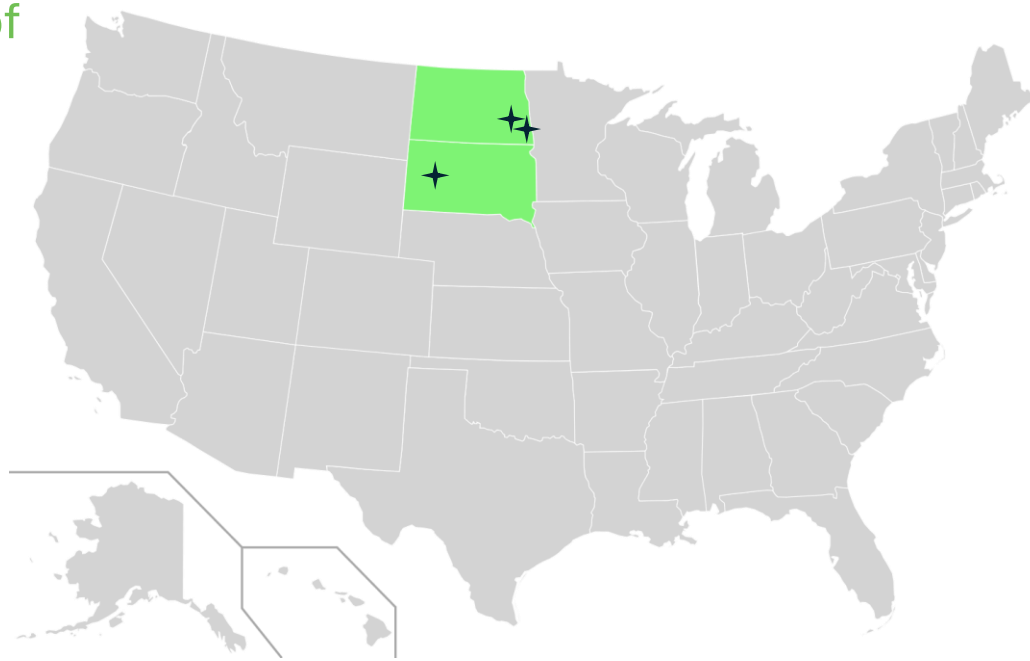
[1]Department of Plant Sciences, North Dakota State University, Fargo, ND

[2]West River Research Farm, South Dakota State University, Sturgis, SD

FROM 03 › TO 06 nov. 2025

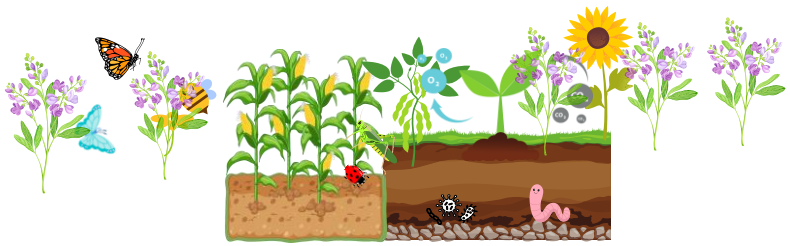
Introduction

- By integrating alfalfa (*Medicago sativa* L.) into cropping systems in the Upper Midwest, we have a great potential **to increase cropping system sustainability** by reducing the need of chemical nitrogen fertilizer by non-N_2 fixing crops.



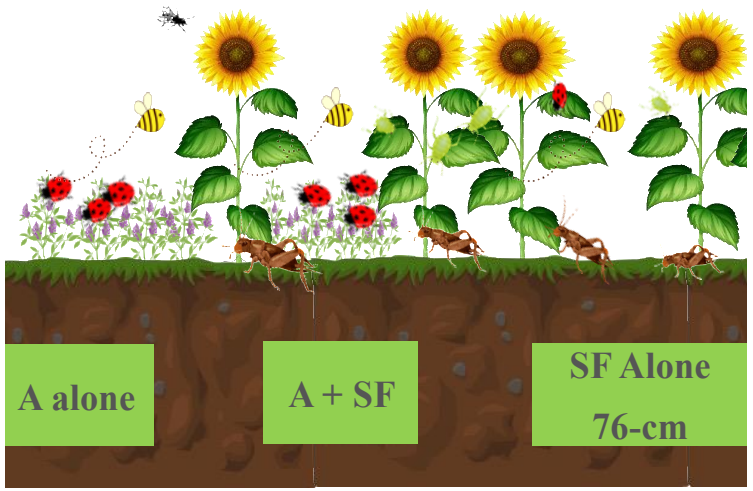
- North Dakota and South Dakota
  - 1st and 2nd sunflower planted area (515,000 ha)
  - 3rd and 2nd in alfalfa planted area (1.2 million ha)
- Alfalfa is very slow to establish
- Establish alfalfa while growing a cash crop
  - Intercropping alfalfa with maize, sorghum & **sunflower**
  - N_2 transfer has been shown in other intercropping systems between a legume and non-legume plant.

- The objective of this study was to evaluate biological nitrogen fixation (BNF) and nitrogen transfer between alfalfa and sunflower under monocropped and intercropped conditions.



Methodology

- Locations: Prosper and Hickson, ND; and Sturgis, SD.
- Both sunflower and alfalfa were planted the same day in May 2023 & 2024.

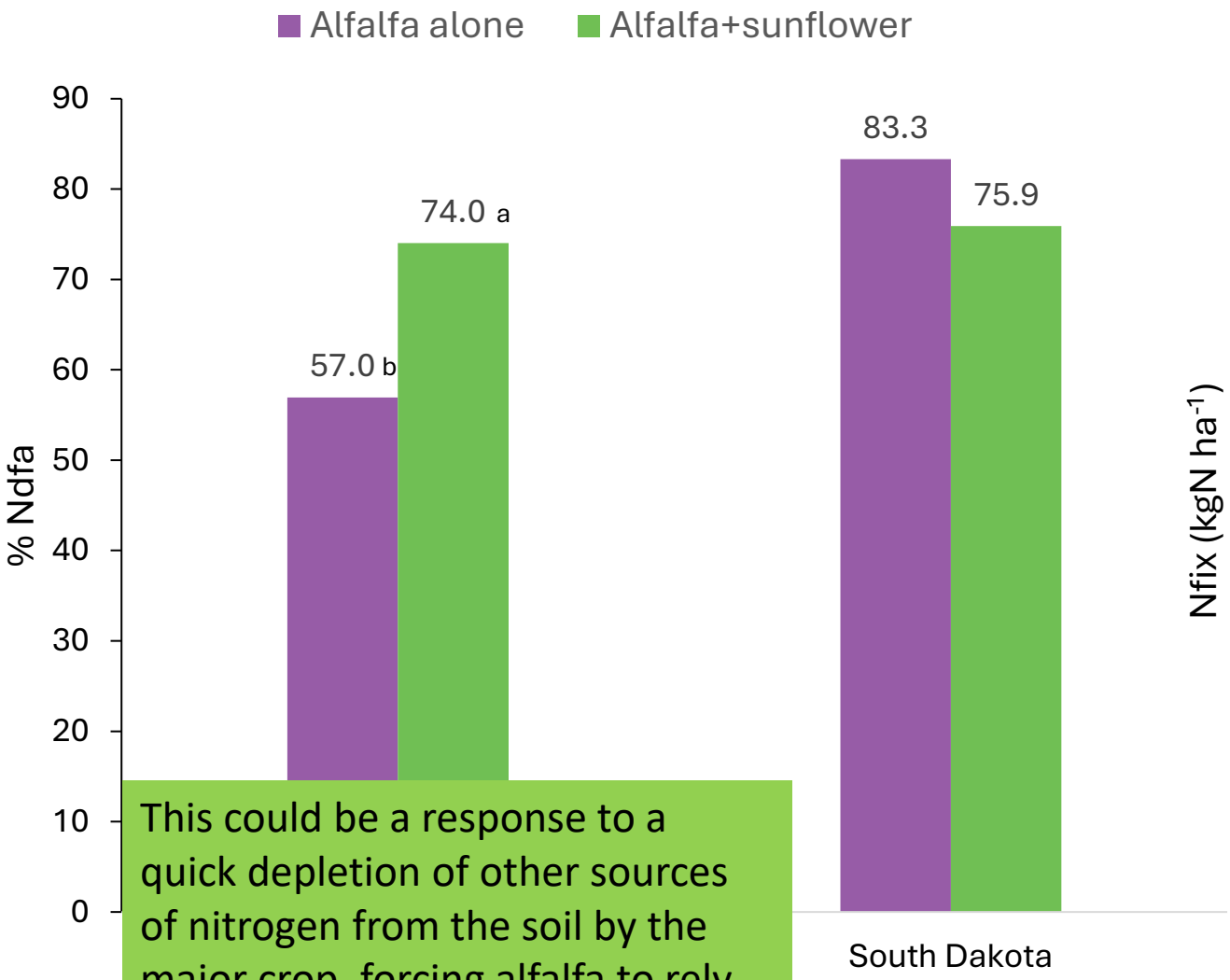


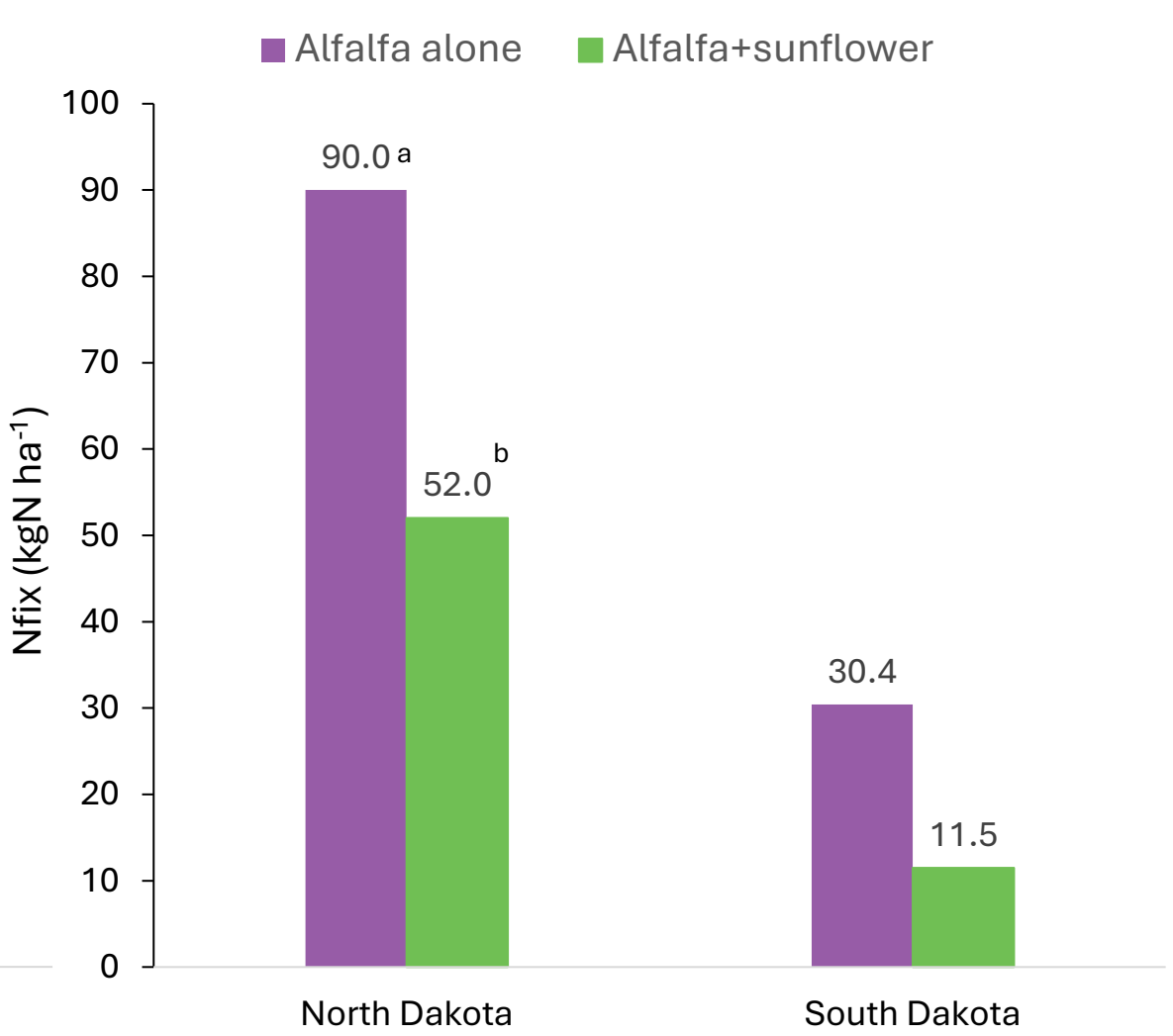
- Ammonium nitrate fertilizer enriched with ^{15}N isotope (10 atom% excess $^{15}NH_4$-$^{15}NO_3$) was applied at a rate of 5.6 kg N ha^{-1} to a micro plot of 1 m^2 of either alfalfa, sunflower or alfalfa intercropped with sunflower.

- All aboveground biomass was harvested from each microplot immediately before harvest.
- Each sample of sunflower was hand-separated into head, stem, and leaves.
- Dried samples were weighed and ground through a 1-mm mesh and samples sent for analysis of ^{15}N atom excess, then the percentage of nitrogen derived from N_2 fixation in alfalfa (%Ndfa) was calculated.

- Ndfa (%): proportion of plant nitrogen derived from N_2 from the atmosphere.
- Nfix (kg N ha^{-1}): total nitrogen fixed by alfalfa or transferred to sunflower.

Results- Nitrogen derived from N_2 fixation in alfalfa

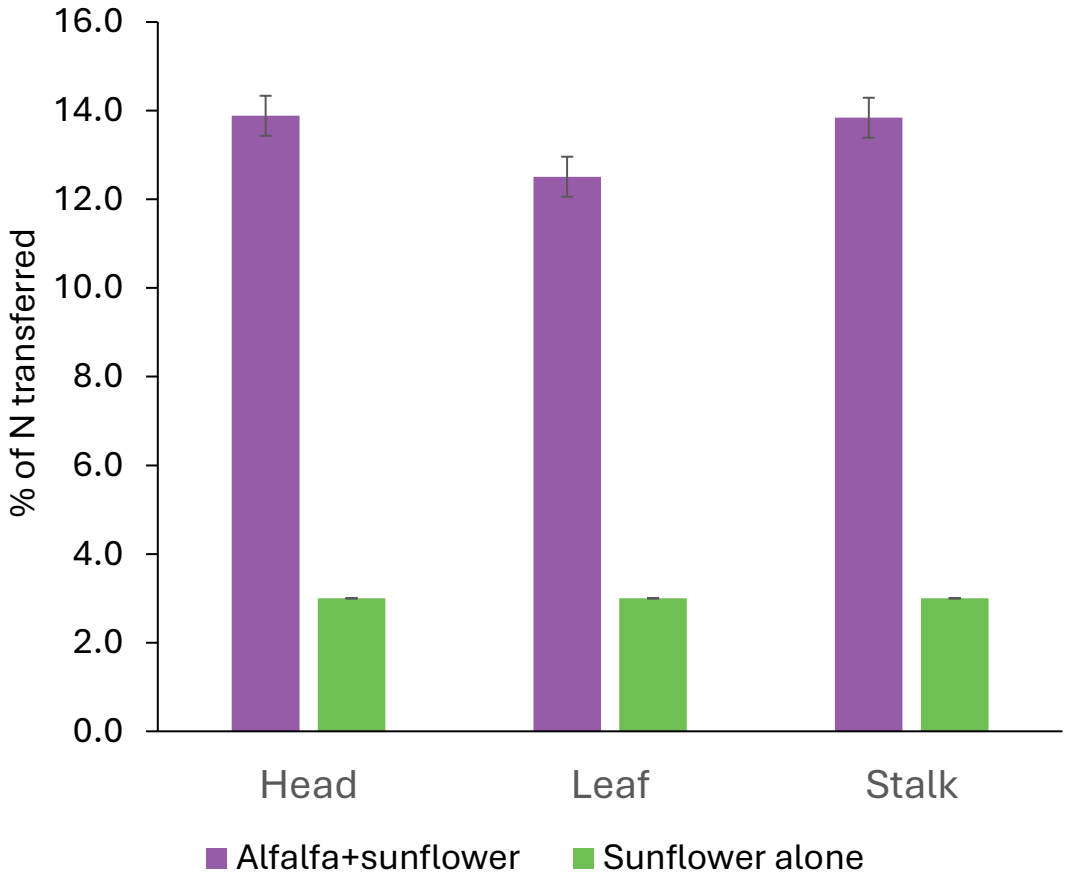




This could be a response to a quick depletion of other sources of nitrogen from the soil by the major crop, forcing alfalfa to rely on N_2 fixation.

Results-Nitrogen transfer to sunflower (%Ndfa) in sunflower

- In North Dakota, sunflower head, leaves and stem, had similar Ndfa ranging between 12.5-13.8% of the total N in each botanical part.
- In South Dakota, on average, intercropped sunflower contained 3.2% Ndfa and 2.4 kg N ha^{-1} Nfix.
- This transfer likely occurred through rhizodeposition, mycorrhizal linkages, or short-term mineralization of alfalfa root exudates and nodular residues.



Conclusions

- Nitrogen derived from biological N_2 fixation was greater in alfalfa under intercropping in ND while the opposite was observed in SD, indicating soil fertility and water stress might have influenced the results.
- Nitrogen transfer from alfalfa was observed at both locations with values ranging from 12.5-13.8% in ND and only 3.2% in SD.
- Establishing alfalfa in intercropping with sunflower among many benefits has the potential of reducing nitrogen chemical fertilization in sunflower reducing sunflower's carbon intensity.

Funding provided by USDA-NIFA-ASAFS. "Establishing alfalfa in intercropping with sunflower and sorghum to improve alfalfa yield and profitability" Award no. 2022-70005-38225

Thank you!

marisol.berti@ndsu.edu

USDA NIFA