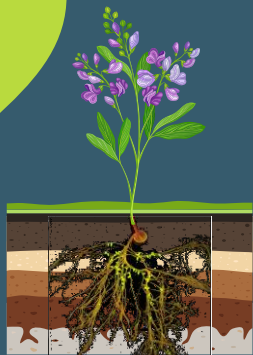




INTERCROPPING IN CORN AND OTHER CROPS

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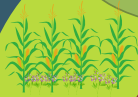
Intercropping




Growing two or more crops in the same piece of land unit

- Two grain crops
- Grain-forage crops**
- Two forage crops
- Interseeded cover crops**


- Increase yield per unit land
- Efficient use of resources
- Reduces soil erosion
- Enhances soil health
- Reduces GHGs emissions
- Increases biodiversity



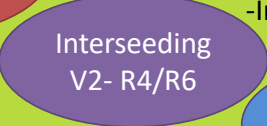
Mixed Intercropping




Row intercropping



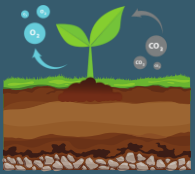
Relay-intercropping




Interseeding V2- R4/R6



Strip-intercropping



2



Interseeding cover crops into corn and soybean

Interseeding in corn and soybean

- Cover crops species:
 - cereal rye, faba bean, pea, crimson clover, balansa clover, radish, winter camelina
- Interseeding dates
 - V6-R6 Corn , R4-R6 Soybean
- Seeding methods
 - broadcast vs. interseeder
- Nutrient cycling-corn
 - no response in corn

Results

Establishment:

- better drill vs. broadcast
- better rye vs. others
- highly dependent on rainfall
- in soybean, after leaf drop best
- in corn, V6 better than R6 or later
- **In summary, in ND interseeding cover crops into standing corn or soybean is difficult and unreliable.**

Short growing season
Wet springs
Dry fall
Early fall frost

NDSU NORTH DAKOTA STATE UNIVERSITY

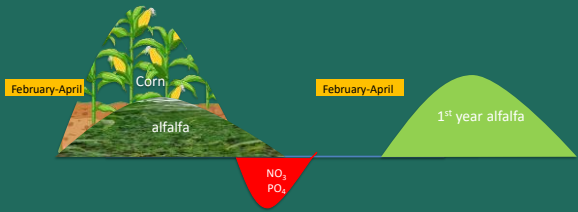
Peterson et al., 2019; Berti and Samarappuli, 2018; Andersen et al., 2020;; Mohamed et al., 2020; Johnson et al., 2021, Schmidt et al., 2021

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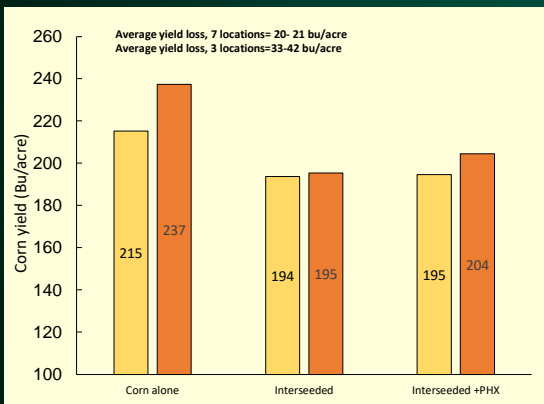
Alfalfa-corn intercropping



Corn and alfalfa planted at the same time

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Corn grain yield



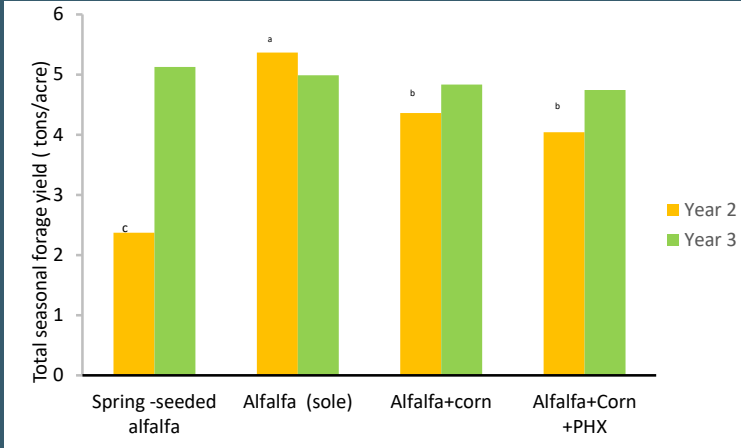
- Yield reduction 20-42 bu/acre



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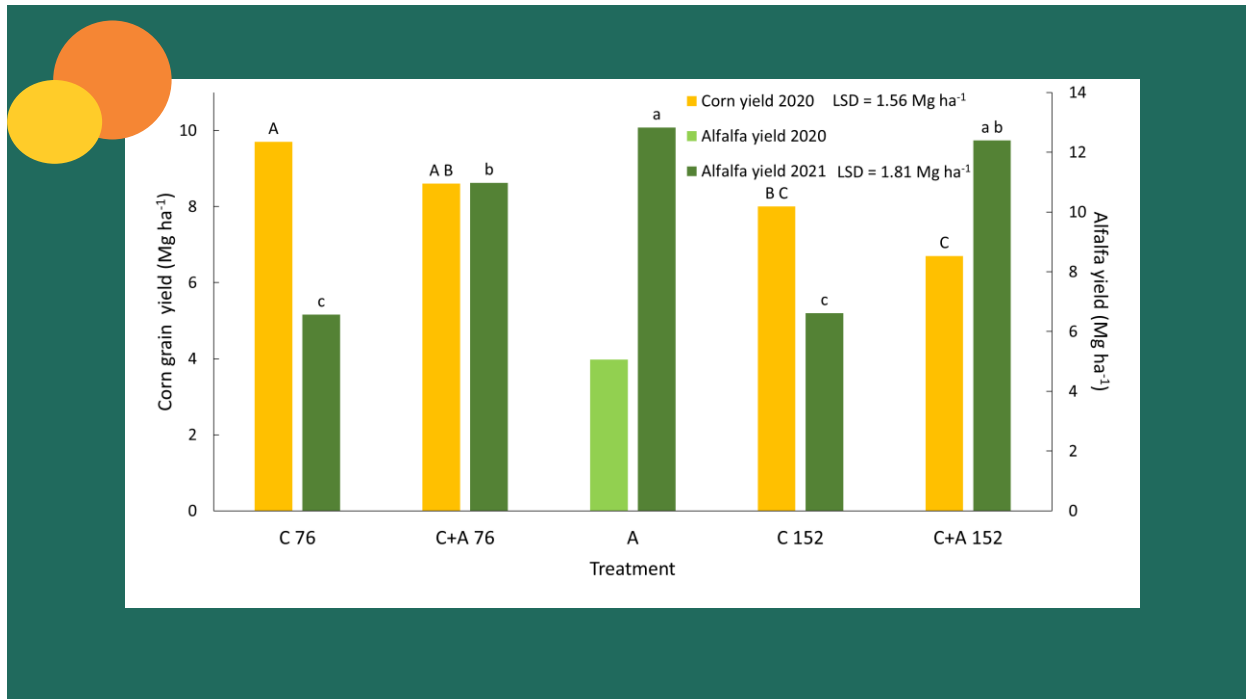
Alfalfa forage yield

Total alfalfa yield in the first production year is higher when established in intercropping than a spring-planted alfalfa
 Corn-alfalfa intercropping had higher returns than corn monoculture



Berti, M.T., J. Lukaschewsky, and D.P. Samarappuli. 2021. Intercropping alfalfa into silage maize can be more profitable than maize silage followed by spring-seeded alfalfa. *Agronomy* 11(6), 1196; <https://doi.org/10.3390/agronomy11061196>
 Berti, M.T*, A. Cecchin, D.P. Samarappuli, S. Patel, A.W. Lenssen, K.J. Moore, S.S. Wells, and M.J. Kazula. 2021. Alfalfa established successfully in intercropping with corn in the US Midwest. *Agronomy* 2021, 11, 1676 <https://doi.org/10.3390/agronomy11081676>

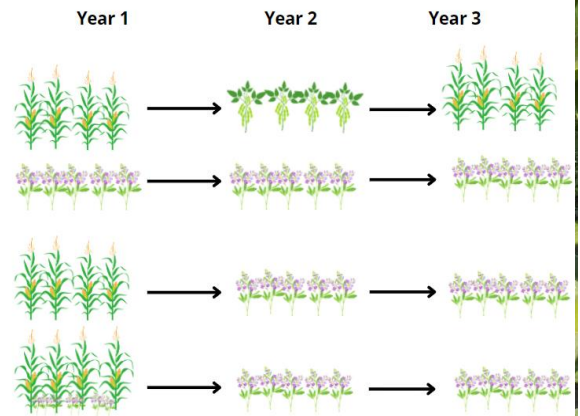
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Alfalfa-corn intercropping impact on soil C, nitrous oxide, and nitrate leaching

- 3-year sequences CSC, AAA, CAA, CAIAA
- Modeled with DNDC as a transition no tillage
- Soil C balance, and total nitrous oxide, and nitrate leaching in 3 yrs
- Fertilization
 - Corn: 124-0-0, N-P-K (kg/ha)
 - Alfalfa: 0-67-112 (kg/ha)
 - Soybean: 0-67-0 (kg/ha)

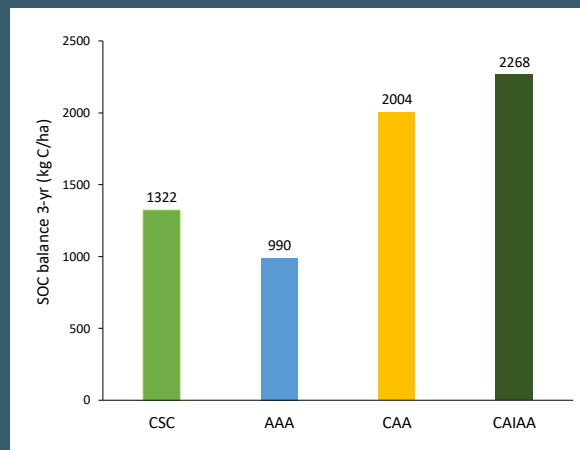


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Soil C balance of alfalfa-corn intercropping



- Soil C balance in four cropping systems in 3-years (sum), modelled with DNDC.
- Positive value indicates there was more C staying in the system than leaving the system.
- All residues of corn and soybean staying in the field
- Alfalfa alone has lower C balance, it is harvested and removed from the field.
- Corn-alfalfa systems have higher C balance, because in Year 1 corn residue and roots of alfalfa sequester C in the soil.



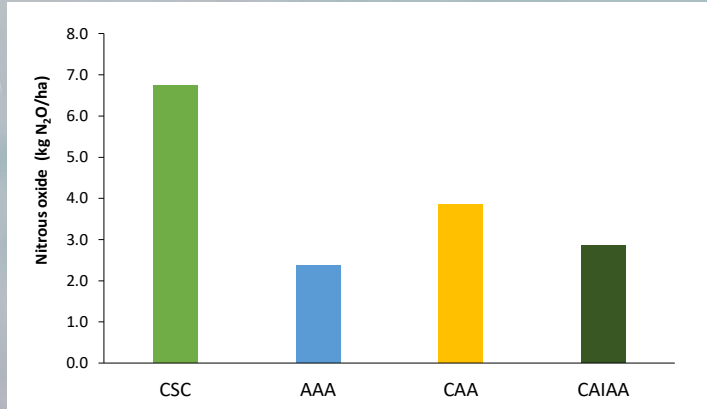
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Field nitrous oxide emissions



Nitrous oxide is a potent greenhouse 298 x than CO₂

It mainly comes from denitrification chemical nitrogen fertilizer

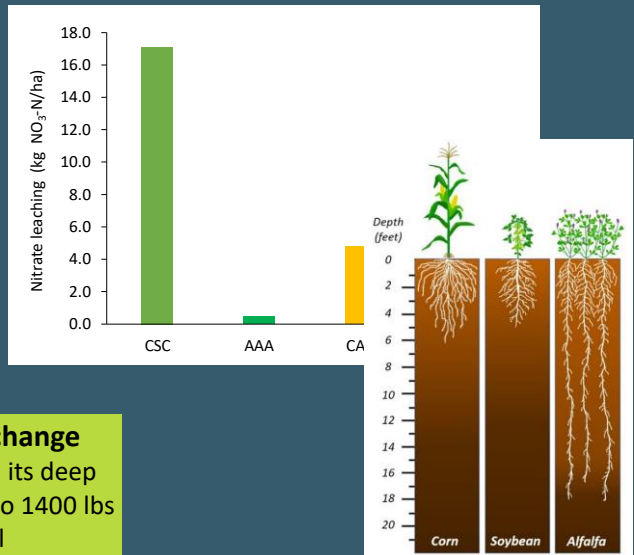


Corn-soybean-corn largest 3-year nitrous oxide emissions

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Nitrate leaching

- Systems with alfalfa had much lower nitrate leaching potential than corn-soybean-corn.
- Alfalfa it is known as a excellent scavenger of nitrate. Very deep root system.



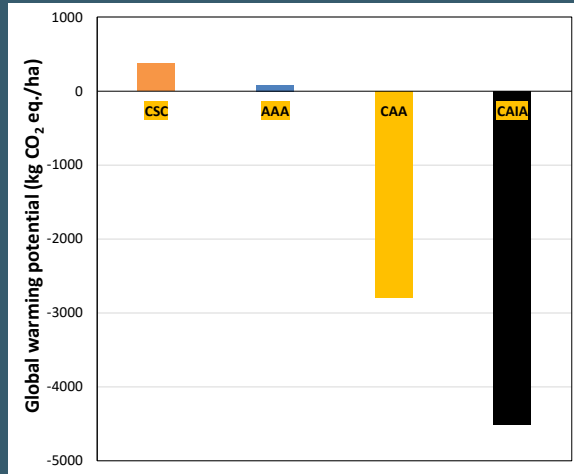
Alfalfa can store carbon and slow climate change

Alfalfa is a crop that grows rapidly and stores C in its deep roots. In a year, an acre of alfalfa can transfer up to 1400 lbs of carbon dioxide from the atmosphere to the soil

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Global warming potential

- The net GWP were negative as modelled with (LCA) in the CAA and the corn-alfalfa intercropping system in 3 years.
- Including alfalfa in a cropping system in ways alone or intercropping with corn, we greatly reduce GWP.
- Increase in soil C sequestration



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Corn-alfalfa intercropping - biodiversity

Corn

Alfalfa

Corn-alfalfa

AMF root colonization (Percentage)

North Dakota South Dakota

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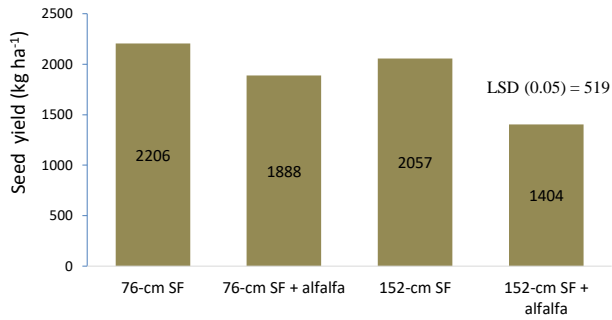
Sunflower-alfalfa intercropping

North Dakota and South Dakota are the main sunflower producers
 Alfalfa provides numerous benefits
 -weed suppression
 -improved soil health
 -enhanced biodiversity
 Establish alfalfa in intercropping with sunflowers

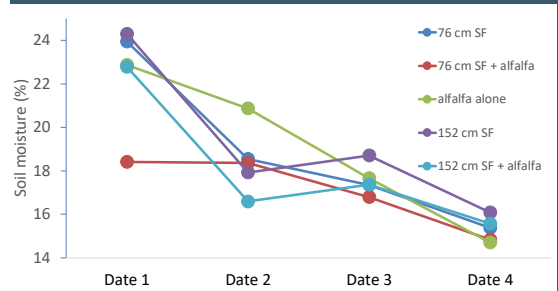


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Sunflower achene yield and soil moisture

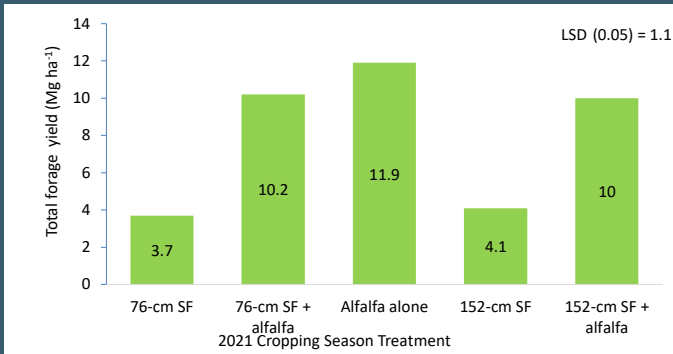


Achene yield was the same among treatments
 Soil moisture decreased faster in treatments with alfalfa

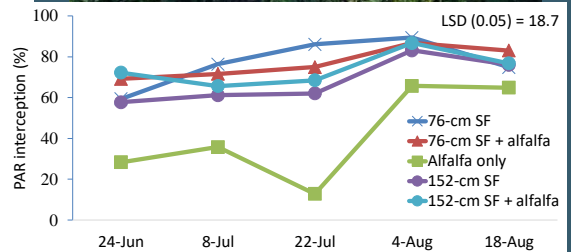


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Alfalfa forage yield and light interception



Alfalfa forage yield in the following year was more than double in the alfalfa that was intercropped with sunflower the year before



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Grant Funding

- USDA-NIFA-ASAFS 9/2022-8/2024. Establishing alfalfa in intercropping with sunflower and sorghum to improve alfalfa yield and profitability, PD, Award no. 2022-70005-38225, \$587,671
- USDA-NIFA-SAS. 10/2021-9/2026. Fostering Resilience and Ecosystem Services in Landscapes by Integrating Diverse Perennial Circular Systems (RESILIENCE CAP). Award no. 2021-68012-35917; \$9,999,978 (to my program \$747,868). Agronomy Research lead, co-PD

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Thank you!

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