

Table of Contents

Nafchi, Ali - #1827 - Development of an Inexpensive Y-drop System Combined with a Cover Crop Planter to Improve Nitrogen Use Efficiency While Inter-Seeding Cover Crops.....	1
Interim Report - Due July 1, 2022.....	1
Interim Report - Due July 1, 2022.....	3

Progress Report

2022 South Dakota Nutrient Research and Education Council Invited Proposals

Progress Report Title:	Interim Report - Due July 1, 2022
Applicant Name:	Ali Nafchi
Application Title:	Development of an Inexpensive Y-drop System Combined with a Cover Crop Planter to Improve Nitrogen Use Efficiency While Inter-Seeding Cover Crops.
Application ID:	1827
Review Deadline:	07/1/2022 11:59 PM

Interim Report - Due July 1, 2022

Project

	Start Date	End Date
Start and End Dates of Funding:	01/1/2022	12/31/2022
Title of Project:	Development of an Inexpensive Y-drop System Combined with a Cover Crop Planter to Improve Nitrogen Use Efficiency While Inter-Seeding Cover Crops.	

Project Description:

Summary: Improving the Nitrogen Use Efficiency (NUE) and prevention of N leaching is a big step to increase yield and achieve higher water quality. Previous works have shown that N can easily leach to the lower soil layers and become inaccessible to the plant and providing N close to the root system may increase the NUE. Using the Y-drop method allows applying the nitrogen close to the plants and makes it more accessible for plant uptake, decreasing the N leaching, and may suppress weed infestations by not providing them N. Compared to the row middle N injectors and broadcasters, the Y-drop method provides more accessible N for the plant to uptake, and combining the Y-drop applicator with a cover crop inter-seeder helps to improve the NUE and environmental quality. On the other hand, scientists in the U.S. have successfully tested cost-effective cover crop-based crop production systems under different soil conditions during the past several years. However, the short growing season in South Dakota and delayed planting usually make it very challenging to establish a good stand of cover-crop after harvesting the corn in the fall. Many growers/researchers have been attempting to broadcast cover crop seeds in standing crops. They have also been trying to use hi-boy planters for inter-seeding the cover crops. However, non-uniform stand in broadcasting method due to inadequate soil contact with seeds, as well as the high price of the hi-boy planters, are challenging. Despite the belief in in-season cover-crop-plant competition among the farmers, research at Pennsylvania, New York, and Maryland has shown promising success on early in the season cover crop inter-seeding, letting them grow under the main growing crop. For inter-seeding the cover crops early in the season, Penn State University has developed a cover crops inter-seeding machine to plant the cover crops after planting early in the season. However, this machine can inter-seed and apply fertilizer simultaneously; still, the cost and risk associated with the inter-seeding need to be reduced to become affordable for farmers. Due to these challenges, supporting information on the quantified impact of in-season cover crops (double cropping system) on soil water in cropping systems in South Dakota is currently lacking. Therefore, we propose: a) develop an affordable planter equipped with the Y-drop N applicator suitable for planting different cover crops seeds, b) quantify the performance of the Combo Y-drop-cover-crop-Planter, c) study the effect of Y-drop N application and compare the crop response and growth in different conditions, d) study the effects of in-season cover crop performance concurrent with N application on NUE, soil fertility, water quality, crop yield, and farm profits, and e) implement a progressive program to disseminate the results to the stakeholders/end-users. The overall outcome of this project is to introduce innovative technologies that conserve soil, reduce crop inputs, and enhance drought resilience. The total requested fund for this three-year project is \$240,019. The total requested budget for year one is \$103,907.

Publications

Publication Title:	Development of an Inexpensive Y-drop System Combined with a Cover Crop Planter to Improve Nitrogen Use Efficiency While Inter-Seeding Cover Crops.
Publication Date:	07/1/2022
Status:	On-going
Publication Description:	NA

South Dakota Nutrient Research and Education Council Proposals Biannual Progress Report - 1

Project Title:

Grantee Name: South Dakota State University	
Development of an Inexpensive Y-drop System Combined with a Cover Crop Planter to Improve Nitrogen Use Efficiency While Inter-Seeding Cover Crops.	
Ali Mirzakhani Nafchi, Assistant Professor, Precision Ag Ext. Agronomy, Horticulture, and Plant Science & Agricultural and Biosystems Engineering	
Contact Information:	Phone Number: (863) 325-6434 E-Mail: ali.nafchi@sdstate.edu
Period Covered by Report:	January 01, 2022, to July 01, 2022
Project End Date:	December 31, 2024

Improving the Nitrogen Use Efficiency (NUE) and prevention of N leaching is a big step toward increasing yield and achieving higher water quality. The main project goal, in line with USDA-Natural Resources Conservation Service (NRCS) goals, is to investigate and demonstrate different methods and concepts in applying nitrogen combined with cover crop planter.

Using the Y-drop method allows applying the nitrogen close to the plants and makes it more accessible for plant uptake, decreasing the N leaching, and may suppress weed infestations by not providing them N. On the other hand, the short growing season in South Dakota usually makes it very challenging to establish a good stand of the cover crop after harvesting the corn in the fall.

This project will introduce innovative technologies that conserve soil, reduce crop inputs, enhance farm profits, soil health, and environmental quality and help growers make informed decisions.

Summarize the work performed during the project period covered by this report:

The team members on this project, “Development of an Inexpensive Y-drop System Combined with a Cover Crop Planter to Improve Nitrogen Use Efficiency While Inter-Seeding Cover Crops,” had a meeting on January 7th, 2022 (planning meeting) to discuss the project’s action plans.

We also had several in-person brains-storm meetings to discuss the design and the system requirements.

Presentation outreach to introduce the project:

2022 Crop Hour presentation: March 2nd, 2022.

- Precision Agriculture and Sustainability: <https://www.youtube.com>

Poster presentation on CAFES Research Summit

- Develop Precision Cover Cropping System and Improve the Nitrogen Use Efficiency
- Seed Coating: A based Biodegradable Approach to Delay Seed Germination

Recruiting the students

Two graduate students will be working with the team on the project's tasks, including fabrication, field and lab data collection, analyzing results, and project evaluation tasks.

We recruited two students in January and February 2022; however, due to visa status, there was a delay on starting date. Only one student started working on this project as a GRA on May 21st, and another student is waiting to change his status from F2 to an F1 visa to be able to participate in this project (the student is here in Brookings, SD).

Y-drop cover crop planter, design and fabrication

Cover crops have been shown to improve organic matter and increase water infiltration rate and water holding capacity in the soil, all factors that lower the severity of both drought and flood situations, especially in minimum or no-till systems. The inter-seeder provides a good seed-soil contact, and at the same time, the Y-drop N side-dress applicator applies the N adjacent to the plants (closer to the root system) to improve NUE. We have designed a Y-drop System Combined with a Cover Crop Planter to assist SD farmers with limited resources or technology to improve management for farms of all sizes, especially small farms. Several South Dakota farmers are interested in participating and trying new and innovative technologies. We will work with these farms to establish on-farm research and outreach activities called "Prototype fields." At this time, we are developing an inexpensive Y-drop Cover Crop planter. We will then establish interested corn and soybean side-by-side with standard crop production practices for comparison. The interseeding units is compatible with growers' existing equipment to be retrofitted on their existing fertilizer applicators, and we will provide training and support to ensure proper use of the system.

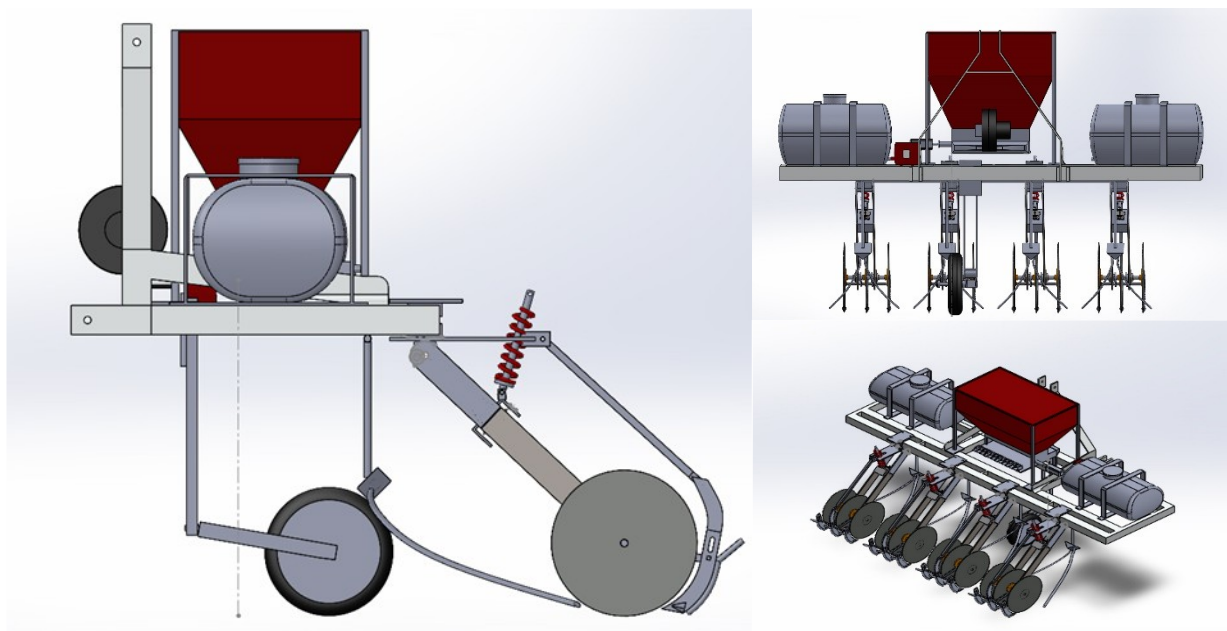


Figure 1. Y-drop cover crop planter (Design is almost completed and fabrication has started).

Our team of agricultural engineers, agronomists, and soil scientists collaborating in this project, is ideal to address this project's multidisciplinary challenges.

On our on-farm activity, we are working with growers and NRCS Conservationist across the State as they will be involved with the informational products produced through the life of this project. We have used the yield data and the grower's knowledge to create "management zones". These maps allow visualization of textural differences referred to as "management zones" in these fields and vary the seeding rates across their fields. As this year yield data may entirely change on different year, finding a correct interpretation of why these changes have happened is very important. Easy solution of averaging the historical yield data is usually not really a good idea. We will use a commercially available electrical conductivity (EC) meter (EM-38) in addition to the historical yield data to map soil texture variations in the fields. We will establish three inter-seeded/Y-dropped cornfields, side-by-side with standard crop production practices for comparison.

The work that we anticipate completing in the next six-month period:

- Completing the fabrication of the instrumented SDSU, Y-drop cover crop planter.
- Test and evaluate the performance of the Y-drop cover crop planter.
- The soil EC maps for the fields will be created and soil compaction measurements will be done.

Demonstration field days and workshops will be conducted during the next season to demonstrate the Y-drop cover crop planter concept and discuss them with local growers, consultants, landowners, and industry leaders.

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Date:

7/01/2022