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

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.		
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Period Covered by Report:	January 01, 2022, to January 31, 2023	
Project End Date:	June 31, 2023	

Problem Statement

Using the cover crops in SD is not vastly adopted due to the short growing season and misconception about competition between the cover crop and the main crops. Despite their numerous benefits in promoting soil health, reducing erosion, and controlling weeds, cover crops planted after corn and soybean harvest sometimes do not reach their economic breakeven due to limited time for growth and development before the winter. This shortened growing period can also lead to early death, reducing their potential benefits. This problem is of particular concern in regions with short growing seasons or unpredictable weather patterns, where the window for planting cover crops may be even smaller. As a result, growers may miss out on the long-term benefits of cover crops, such as increased soil organic matter and improved soil structure. Finding a solution to this problem is crucial for promoting sustainable agriculture and improving the long-term health of soils. Therefore, there is a pressing need for research to develop strategies to maximize the use of the growing season, including the hidden idled time allowing cover crops to produce a higher dry matter (Figure 1).

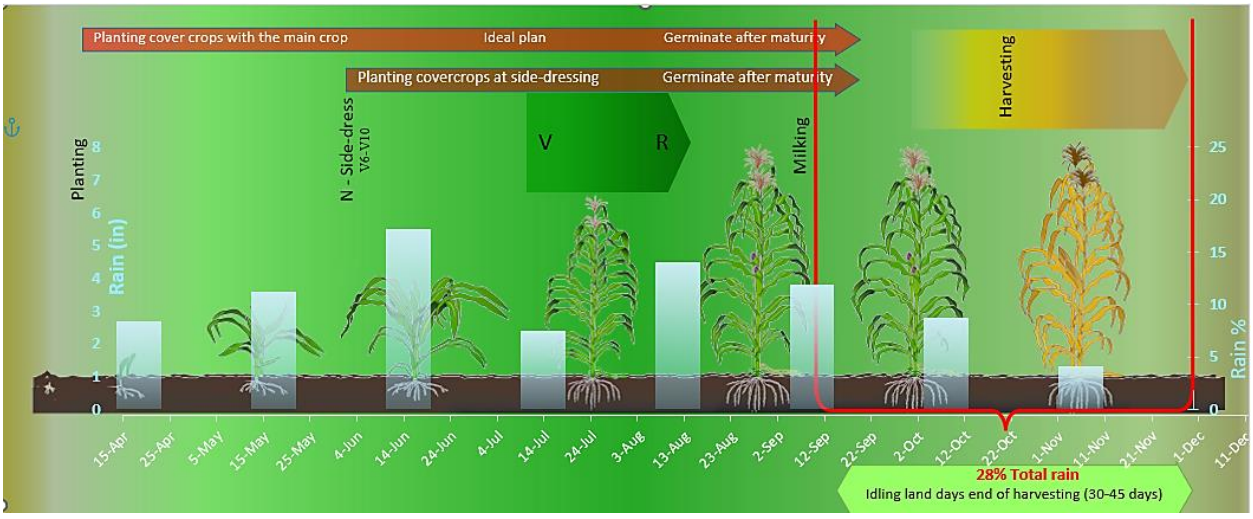

Figure 1. Planting seeds with delayed germination, ideally planting dormant them until the main crop matured, provides an extra valuable growing window with ideal degree days, and reduce the risk related to the short season, and eliminate an additional planting cost.

Cover crops are grown primarily to protect and improve the soil rather than for harvest. They are usually planted during fallow periods or between cash crops to prevent soil erosion, suppress weed growth, and improve soil health. Cover crops can also increase biodiversity, promote beneficial insects and microorganisms, and reduce the need for synthetic fertilizers and pesticides. Here, we will discuss the advantages of cover crops in more detail.

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 December 15th, 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.

Also, in continuation of this work, we have submitted a proposal, "An Innovative Approach to Time Cover Crop Germination that Yields the Highest Value from the Short South Dakota Growing Season," to the South Dakota Board of Regents Competitive Research Grant Program. As many growers/researchers have attempted to use different methods, including broadcasting seeds in standing crops, hi-boy planters for inter-seeding, and airplanes for planting cover crops.

Non-uniform stand due to inadequate soil contact with seeds and the high costs are the barriers to these methods. By coating the cover crop seeds with biodegradable and cost-effective materials, we can postpone their germination by 70 to 90 days, allowing for their planting with the main crop without competing concerns. As a result, providing an extra valuable growing window with ideal degree days (with idled available inputs) can maximize the cover crops benefits, reduce the risk barriers related to the short season, and eliminate an additional planting cost while improving farm benefits.

This project aims to turn the idling land, time (from the period that main crops like corn and soybean just got matured and have completed their production activities until harvest), and other "use it or lose it" inputs into a high-value opportunity, improving the benefits of cover crops.

We intend to introduce several novel approaches to seed coating that have not been previously explored. This proposal is the first to apply seed coating on cover crops, potentially improving their performance and sustainability.

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, one started working on this project as a GRA on May, and another student started from January 2023 to participate in this project.

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.

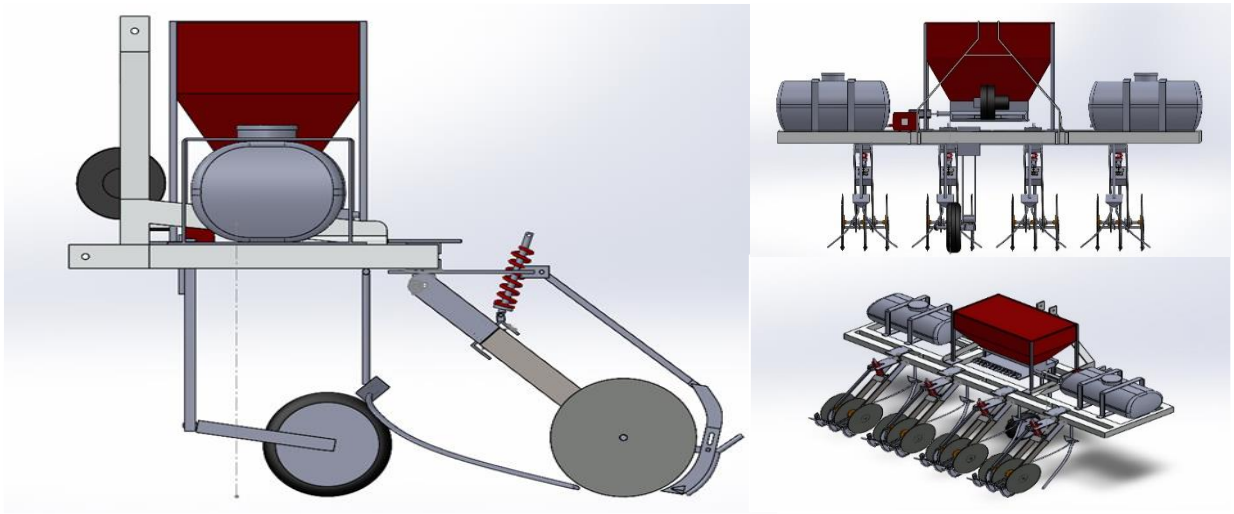

Figure 2. Y-drop cover crop planter (Design completed and fabrication will be completed in three months).

Work Completed

In phase one of this project, we completed the design of a Y-drop System Combined with a Cover Crop Planter. The interseeding units will be compatible with growers' existing equipment (in the future can be retrofitted on their existing fertilizer applicators, and we will provide training and support to ensure proper use of the system). The fabrication of the planter has started and will be completed in about six months to assist SD farmers with limited resources or technology to improve management for farms of all sizes, especially small farms.

Figure 3. Three row inter-seeder planter

The field testing of two (first design and modified) designs revealed that the new opener with 440 lbs downforce is sufficient to maintain the planting depth between 1.75 to 2 inches. The forward speed was 3.7 mph on a no-till practice (Figure 5).

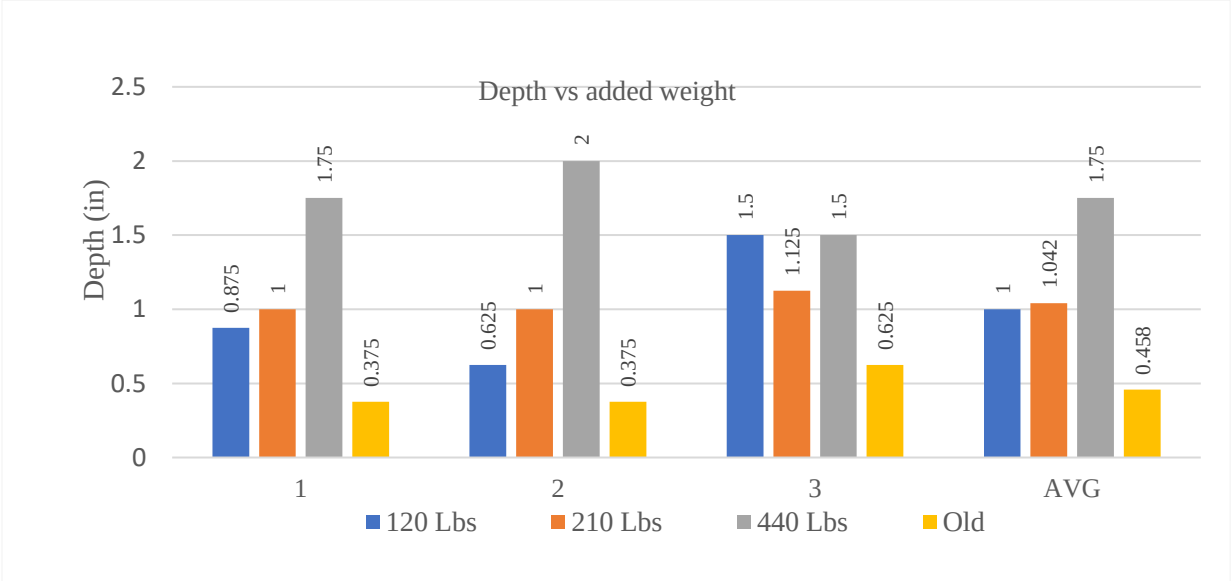

Figure 4. Field testing results for different downforce level.

Work Remaining and Timeline

In phase two of this project, 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." We will then establish interseeded cover crops in corn and soybean field side-by-side with standard crop production practices for comparison. We will interseed cover crops such as rye, tillage radish, and/or crimson clover as the second crop into corn or soybean after planting and before harvesting. In about September, when the main crop leaves dried and dropped, sunlight could go through, and the cover crop will take off, resulting in a well-established cover crop after harvest where we usually do not have enough degree days to get a cover crop established here in South Dakota.

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 us 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.

Remaining work – project phase II

- The fabrication of the planter will be done in about 3 to 4 months (March-April)
- Refine the design, complete the test, and evaluate the performance of the Y-drop cover crop planter (April-May).

The work that we anticipate completing in the next four-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.
- Work with farms to establish on-farm research "Field test" and outreach activities "Prototype fields."

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.

Project Director: Date:

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