



University of Nebraska-Lincoln

Cover Crop Decision Support System (CCDSS)

A Comprehensive User Guide

Cover Crop Decision Support System (CCDSS): A Comprehensive User Guide

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1. Introduction

1.1.Purpose of the Document

This documentation is designed to facilitate the effective use of the Cover Crop Decision Support System (CCDSS). It aims to provide comprehensive guidance to ensure that users can fully leverage the tool to enhance their decision-making capabilities in managing cover crops.

1.2.Overview of CCDSS

The Cover Crop Decision Support System (CCDSS) is an innovative web-based tool that integrates the Decision Support System for Agrotechnology Transfer (DSSAT) to provide a dynamic platform for simulating and evaluating cover crop management strategies. This tool enables users to input specific agricultural data—such as soil conditions, cover crop species, planting and termination dates—and uses these inputs to simulate potential outcomes on soil health and crop yield. By offering visualizations of these simulations, CCDSS helps in understanding the complex interactions between various management practices and their long-term impacts on farm productivity and sustainability. This system is particularly valuable for exploring the effects of different cover crop strategies, aiding in making informed decisions that align with sustainable agricultural practices.

1.3.Audience

This guide is intended for a diverse audience including farmers, agricultural advisors, and researchers who are interested in applying cover crop strategies effectively. It is also useful for technical staff involved in maintaining or integrating CCDSS within broader agricultural management systems.

1.4.How to Use This Document

Sections of this document are structured to guide you from general information about the system to detailed instructions on its use. Readers can navigate through sections relevant to their specific needs, whether they are setting up the system for the first time, looking to understand its functionalities, or interested in technical details.

1.5.Contact Information

For further assistance or to provide feedback on CCDSS, please contact our support team at:

- Email: [ashiferaw2@unl.edu] (mailto:ashiferaw2@unl.edu)
- Phone: 402-472-2565
- Address: 812 South Hardin Hall, 3310 Holdrege Street, Lincoln NE 68583–0988
- For frequently asked questions, please visit our [FAQ page] (http://ccdss.unl.edu/FAQ.aspx). This resource contains answers to common questions and may help resolve your issue more quickly.

We are committed to continuously improving the system and value your input.

2. SYSTEM OVERVIEW

2.1. PURPOSE OF THE CCDSS

The Cover Crop Decision Support System (CCDSS) is designed to assist farmers and agricultural advisors in making informed decisions about cover crop management. It integrates scientific data and modeling to predict the outcomes of various cover crop strategies, helping to optimize soil health benefits and main crop performance.

2.2. KEY COMPONENTS

- **Integrated User Interface:**
  - **Functionality**: This unified interface serves both as the input gateway where users enter crop management data and the output platform where simulation results are displayed.
  - **Features:** The interface is designed to be intuitive, guiding users through data entry, model parameter selection, and visualization options for results.

- **Crop Model Simulations:**

  - **Core Modeling**: Utilizes the Decision Support System for Agrotechnology Transfer (DSSAT) crop modeling system to simulate crop growth scenarios based on user-defined parameters.
  - **Adaptability**: Capable of modeling various scenarios by altering inputs like crop type, planting dates, and soil conditions to predict outcomes such as yield and biomass.

- **Post-Processor:**

  - **Data Handling**: Manages the vast array of parameters produced by DSSAT simulations, extracting specific parameters based on user requests. It also performs simple summaries, such as averaging results across multiple years of simulations, to provide clear, actionable outputs.
  - **Visualization:** Provides visualization tools that include summary tables, bar plots, and time series plots. These tools allow users to compare the outcomes of multiple simulations simultaneously or track changes in desired parameters over time, enhancing the decision-making process.

2.3. FUNCTIONALITY

CCDSS facilitates detailed scenario analyses, enabling users to evaluate the impact of various cover crop management practices on both soil health benefits and main crop performance. This includes evaluating different planting and termination dates, species selection, and other agronomic factors to determine the best strategies that maximize cover crop benefits while minimizing tradeoffs on main crop productivity.

2.4. BENEFITS TO USERS

By providing a platform to explore the potential benefits of different cover cropping strategies, CCDSS aids in improving farm management decisions. It empowers users to maximize the ecological and economic benefits of cover crops, contributing to more sustainable agricultural practices.

- **Decision-making Support**: Enhances the ability to make informed decisions by simulating the outcomes of various management strategies under different climate conditions, thus supporting data-driven decision-making.
- **Customization and Adaptability**: can offer tailored recommendations based on specific farm conditions and goals, leading to better resource utilization and optimized farming practices.
- **Educational Value**: Acts as a learning tool, enhancing understanding of the interactions between agricultural practices and environmental conditions.
- **Research and Development**: Facilitates ongoing research, offering a platform for testing hypotheses in cover crop management and driving agricultural innovation.
- **Risk Reduction and Yield Stability**: helps in identifying strategies that mitigate risks associated with climate variability and enhance yield stability.
- **Increased Adoption**: Addresses the perceived risk that cover crops may negatively affect main crop yields by providing evidence-based strategies and outcomes, thereby encouraging wider adoption among skeptical farmers.

3. GETTING STARTED

3.1. ACCESSING CCDSS:

- **URL**: CCDSS can be accessed directly through CCDSS Home. No signup is required to start using the system.
- **Account Benefits**: Users are encouraged to create an account to personalize their experience, save simulation settings, and receive updates on future developments, including the planned rollout of a mobile application.
- **Browser Compatibility**: For the best experience, we recommend using the latest versions of Chrome, Firefox, or Safari.

3.2. NAVIGATING THE INTERFACE

Home Page

- **Overview**: The Home Page serves as a welcoming point and offers general information about the CCDSS, including details about the project, its funding sources, and contact information. This page is designed to give users a comprehensive introduction to the system and its objectives.

Submit Information

- **Accessing Input Forms**: Navigate to the "Submit Information" page from the Home Page. This section is crucial for initiating simulations.

- **Weather Station Selection**: Start by selecting a weather station. Users can choose a station by clicking on a map or entering coordinates, and the system will suggest the nearest station within a specified radius.
- **Input Sections**: After selecting a weather station, users are prompted to fill out various sections including General Info, Main Crop, Cover Crop, Soil, Fertilizer, and Irrigation details. Each section is designed to capture specific data necessary for accurate simulations.

Results

- **Viewing Simulations**: The "Results" page lists all completed simulations, organized by the names entered in the General Info section during data submission.
- **Simulation Details**: Clicking on a simulation displays its metadata and provides graphs for selected parameters. Users can choose to view results in either metric or English units, enhancing usability and accessibility.
- **Navigation Tips**: Familiarize yourself with the layout of the results page to efficiently locate and analyze specific simulation data.

FAQ and Help

- **FAQ Page**: For answers to common questions and troubleshooting, visit the "FAQ" page accessible from the Home Page.
- **Help Resources**: The "Help" page offers additional support and detailed guides on how to use the CCDSS effectively. This section is particularly useful for users needing more comprehensive assistance.

Tips for Efficient Navigation

- **Tool Tips**: Utilize tooltips available throughout the interface for quick hints and explanations of specific features or data fields.
- **Feedback**: Regularly use the contact information found on the Home Page to provide feedback or ask for help, ensuring continuous improvement and personal assistance when needed.

3.3. SIMULATION MANAGEMENT

Simulation management is integral to the CCDSS, enabling users to effectively explore and implement various cover cropping strategies. This section guides you through setting up, running, and analyzing simulations, providing essential insights to enhance your decision-making for optimal farm management. Learn how to fully utilize the CCDSS to achieve better soil health and crop yields.

3.3.1. Creating a New Simulation

To begin a new simulation, navigate from the CCDSS home page to the "Submit Information" page by following this link: Submit Information. Here, users can start the process of setting up their simulation inputs such as weather station, crop type, soil type, main crop, and cover crop species. This initial step is critical as it sets the foundation for the specific scenarios you wish to simulate.

Station Selection: To begin the simulation setup, users need to select their field location using the interactive map (see Figure 1 below). Follow these steps to ensure accurate selection and data retrieval:

1. **Locate Your Field**: Click on your desired area on the map. This action places a red dot marking your field and automatically displays the geographic coordinates on the right side of the map.
2. **Find Nearest Weather Station**:
    - **Set Search Radius**: Specify a search radius in which to find available weather stations, which will be highlighted as blue dots on the map.
    - **Select a Station**: Click on a blue dot to select a weather station. A pop-up window will appear, providing detailed metadata about the station, including type, county, climate division, coordinates, elevation, and period of record.
3. **Confirm Selection**: Once a station is selected, it will automatically populate the "Weather Station" field under the General Info section.
4. **Reset, if Necessary**: If you need to change the location, click the "Reset Location" button to clear your current selection and start over.

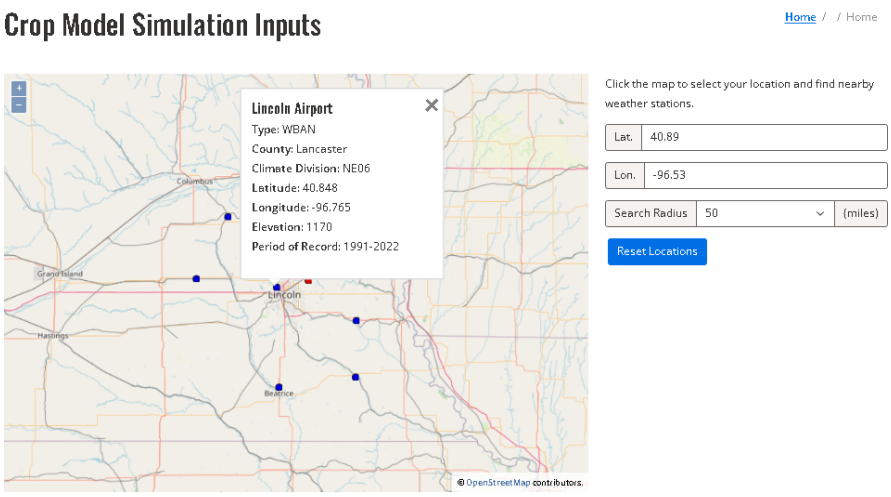


Figure 1: Weather Station Selection Interface

General Information: After selecting a site, users must complete the General Information form. This form gathers essential details that influence the setup and output of your simulation.

- **Name (optional)**: This field is optional and allows you to identify the user if needed. It's useful for tracking who conducted the simulation when multiple users access the system. If left empty, the simulation ID will only include the Site Name.
- **Address**: Enter the physical address or location details of the main site. This helps in associating the simulation with a specific geographic area, aiding in data organization and retrieval.
- **Site Name**: Use this field to uniquely label your simulation. This name, combined with the optional user name, forms the Simulation ID (Name-Site Name). If the Name field is

left empty, the Simulation ID will consist of the Site Name only. This ID helps identify your simulation results on the "Results" page, making it easier to find and compare different simulations.

- **Weather Station**: Automatically populated from your selection in the Station Selection step. It ensures that the simulation uses local climate data, enhancing the accuracy of predictions.
- **Length of Simulation (Years)**: Specify the duration over which the simulation will run. This is used in conjunction with the planting date from the "Main Crop" section to calculate the total years required for the simulation.

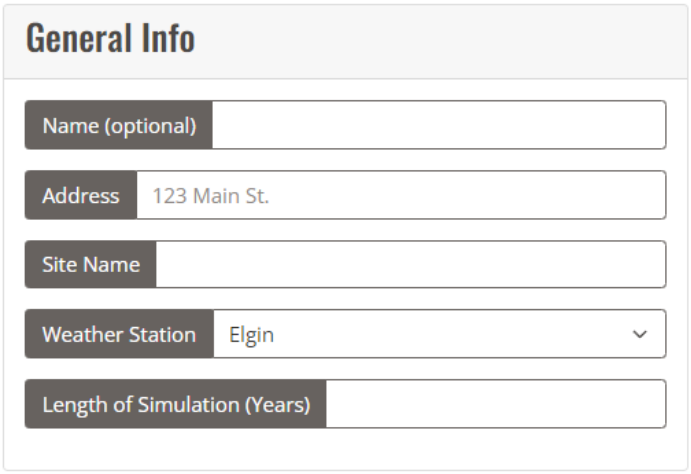


Figure 2: General information Setup Interface in CCDSS

Main Crop: In the Main Crop section, users are required to specify management details about the main crop they are simulating. This information is crucial for accurately simulating crop growth and yield based on the selected parameters.

- **Crop:** Currently, the system supports simulations for Maize (corn). The specific hybrid available for simulation is P1197, a long-maturing pioneer hybrid with a cumulative relative maturity (CRM) of 111 days. To select, click on the dropdown menu next to "Crop" and choose "Maize."
- **Planting Date:** Select a planting date between April 1st and June 10th. This range ensures the crop is planted in its optimal window for growth.
- **Seeding Rate:** Choose from three seeding rates depending on your agricultural practice:
  - Low: 26,400 seeds per acre
  - Medium: 30,400 seeds per acre
  - High: 34,400 seeds per acre
- **Harvest Date:** Specify a harvest date between October 1st and November 10th. This period aligns with typical harvest times for maize, considering the selected hybrid's maturity period.

- **Note:** For simulations spanning multiple years, the system automatically populates the data entered for the first year into subsequent years, simplifying the setup process for extended simulations.

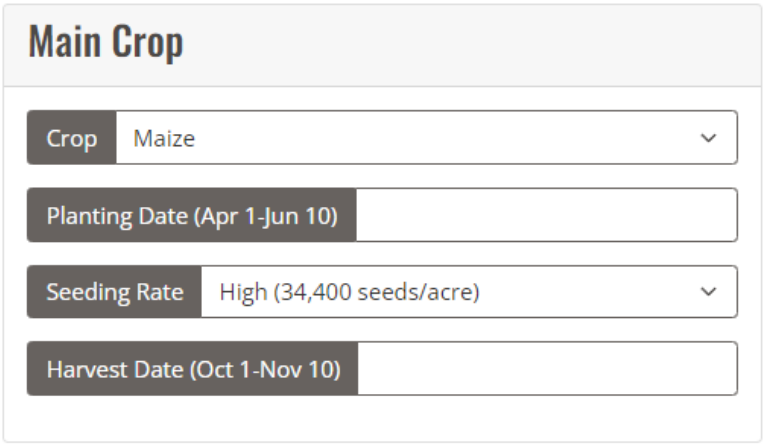


Figure 3: Main Crop Setup Interface in CCDSS

Cover Crop: In the Cover Crop section, users are required to input details about the cover crop they plan to integrate into their crop management system. This information is crucial for simulating the effects of cover cropping on soil health and main crop yield.

- **Crop**: Currently, the CCDSS supports Cereal Rye (Elbon variety) and a "Fallow" option for cover cropping. Select your desired species from the dropdown menu next to "Crop."
- **Planting Date**: The planting date for the cover crop should fall between October 2nd and November 11th. It is important that this date is later than the harvest date of the main crop to avoid conflicts. If a date outside this range or before the main crop's harvest is selected, the system will display an "Invalid Date" error.
- **Seeding Rate**: For Cereal Rye, the system currently provides a fixed seeding rate of 60 lb/acre. Future versions of CCDSS will offer more options for different cover crops.
- **Termination Date**: The termination date must be set between March 22nd and May 31st of the year following planting. Ensure that this date does not extend beyond the main crop's planting date for the upcoming season; otherwise, an "Invalid Date" error will occur. This helps ensure that the cover crop does not interfere with the cultivation of the main crop.
- **Note**: Cover crop management spans two calendar years: it is planted after the harvest of the main crop in one year and should be terminated before the planting of the main crop in the following year. When setting the termination date, remember to specify it for the spring of the year after planting.

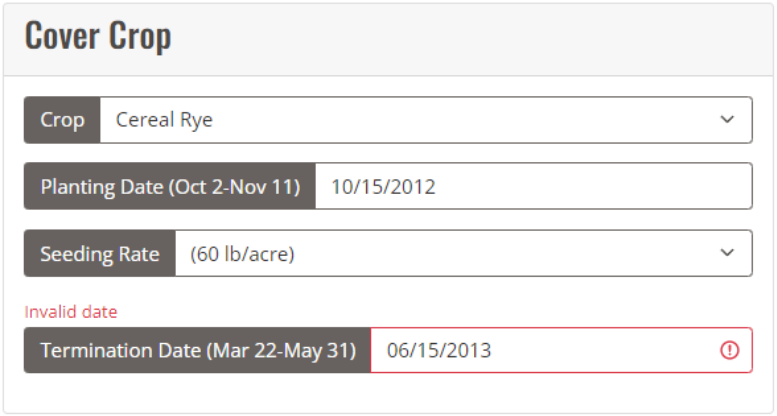


Figure 4: Cover crop Setup Interface in CCDSS

Soil: The Soil section requires users to define specific soil characteristics that are vital for accurately simulating crop growth conditions and outcomes. Understanding these properties helps tailor the crop model simulations to the unique conditions of your farming site. The system utilizes the HC27 Generic Soil Profile Database, developed by Koo and Dimes (2013), which comprises 27 generic soil types (Table 1). Based on the inputs provided in the Soil interface, the system automatically selects the soil type that most closely matches the user-defined characteristics. For further details on these soil types, refer to the dataset archived at Harvard Dataverse: (https://doi.org/10.7910/DVN/90WJ9W).

- **Soil texture:** Select the primary composition of your soil, which can be Sand, Clay, or Loam. This choice determines the soil's water holding capacity and aeration properties.
- **Soil Organic Carbon (SOC) Level:** Indicate the organic carbon percentage in the topsoil, which influences soil fertility and structure. The options are:
  - High (SOC > 1.2%)
  - Medium (0.7% ≤ SOC < 1.2%)
  - Low (0.0% ≤ SOC < 0.7%)
- **Soil Root Depth:** Choose the depth at which your crop roots extend, which affects how well your plants can access water and nutrients. The options include:
  - Deep (> 60 inches)
  - Medium (35 inches to 60 inches)
  - Shallow (< 35 inches)
- **Soil Surface Texture:** This selection should reflect the top layer of your soil, which affects moisture and nutrient flow Options range across 12 classes, including Clay, Loam, Sand, and Silty Clay, among others.

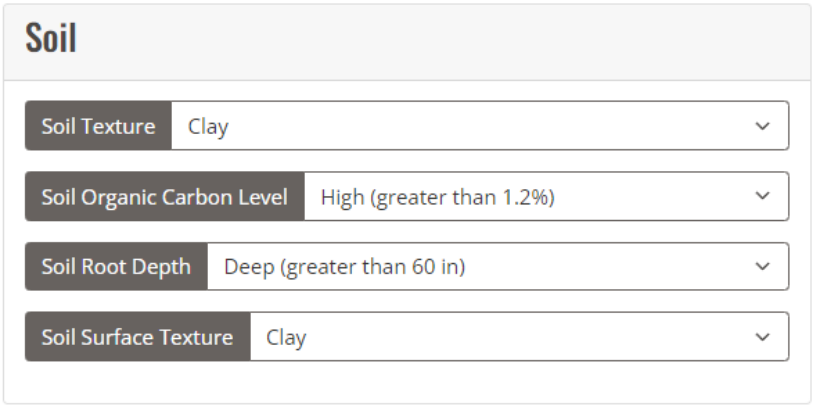


Figure 5: Soil information setup Interface in CCDSS

TEXTURE	%SOC in topsoil	ROOTING DEPTH (cm)	Soil Type
CLAY	HIGH (SOC >= 1.2%)	DEEP (>= 150 cm)	1
		MEDIUM (90<=RD<150)	2
		SHALLOW (0<=RD<90)	3
	MEDIUM (0.7%<= SOC < 1.2%)	DEEP	4
		MEDIUM	5
		SHALLOW	6
	LOW (0.0%<= SOC < 0.7%)	DEEP	7
		MEDIUM	8
		SHALLOW	9
LOAM	HIGH	DEEP	10
		MEDIUM	11
		SHALLOW	12
	MEDIUM	DEEP	13
		MEDIUM	14
		SHALLOW	15
	LOW	DEEP	16
		MEDIUM	17
		SHALLOW	18
SAND	HIGH	DEEP	19
		MEDIUM	20
		SHALLOW	21
	MEDIUM	DEEP	22
		MEDIUM	23
		SHALLOW	24
	LOW	DEEP	25
		MEDIUM	26
		SHALLOW	27

Table 1:The 27 generic soil types used by the CCDSS, derived from the HC27 Generic Soil Profile Database.

Fertilizer: In this section, users are required to specify the amount of nitrogen fertilizer applied to their crops.

- **Fertilizer Amount:** Users select the desired amount of nitrogen fertilizer from predefined increments (100, 120, 140, 160 lb N/acre). This structured approach simplifies the data entry process while providing sufficient detail for the simulation.
- **Default Settings:** While users specify the amount of nitrogen fertilizer, the CCDSS automatically sets other parameters associated with fertilizer management by default, utilizing the most common agricultural practices in the region:
  - *Fertilizer Type:* Anhydrous ammonia.
  - *Application Method*: Injected into the soil.
  - *Application Timing*: A split application strategy is used; half applied at planting, and the remaining half is applied in-season around the V8 growth stage of corn.
  - *Application Depth*: 10 cm (approximately 4 inches).
- **Future Enhancements:** Future versions of the CCDSS will allow users to customize these settings, including the type of fertilizer, application method, timing, and depth. This will enable more tailored nutrient management strategies that better fit specific farm practices and environmental conditions.

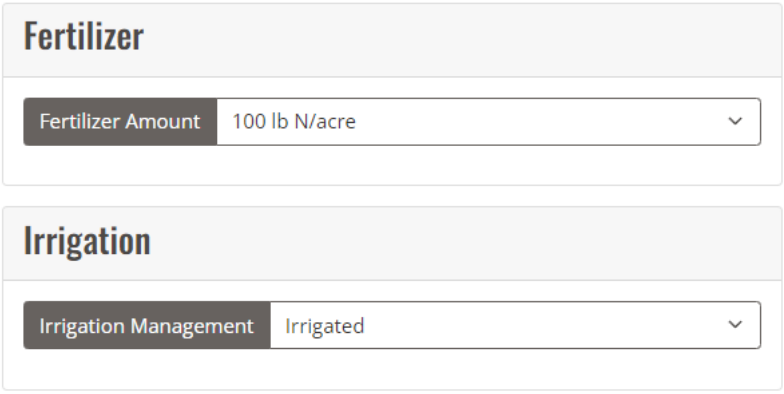


Figure 6: Fertilizer and irrigation management entry menu of CCDSS.

Irrigation: In the irrigation management section, users define the water management strategy for the main crop. Users choose their preferred irrigation method through a dropdown menu with the options "Rainfed" and "Irrigated" (Figure 6).

- *Rainfed*: No additional irrigation is applied, and the crop depends solely on natural rainfall.
- *Irrigated*: This option triggers an automated irrigation strategy with a preset amount and timing of application. This strategy allocates a seasonal total of 160 mm of water, distributed across various growth stages to ensure each stage receives optimal moisture:
  - Vegetative Stage: 50 mm
  - Flowering Stage: 50 mm

    - Grain Filling Stage: 60 mm
- The system ensures there is a minimum interval of 5 days between irrigation events to avoid over-saturation, maintaining ideal soil moisture levels throughout the growing season. This automated approach is based on DSSAT's growth stage-based irrigation algorithm, which tailors water application to the specific needs of the crop at each stage of development.
- **Future Enhancements:** Future versions of the CCDSS will provide users with greater flexibility to customize irrigation settings, including the amount, timing, and methods of irrigation. This enhancement will allow users to align the simulation more closely with actual field practices, thereby improving the accuracy and relevance of simulation outcomes.

3.4. SIMULATION RESULTS

This section of the User Guide helps users understand how to read and analyze the results produced by their simulations within the CCDSS. Effective interpretation of these results is crucial for making informed decisions about crop management and optimizing agricultural practices.

3.4.1. List of Available Parameters

While DSSAT generates a wide range of output parameters, the CCDSS focuses on analyzing and displaying a targeted subset that is most relevant for cover crop decision-making. Below is a table of the key parameters available, which users can reference to assess the effectiveness of different management strategies:

No.	Parameter Description	Name in CCDSS	Unit-Metric (English)
1	Main crop yield [Dry]	Corn Yld	Kg/ha (lb/ac)
2	Cover crop biomass [Dry]	CC Biom	Kg/ha (lb/ac)
3	Cumulative soil evaporation during main crop growing season	MC soil Evp.	mm (inches)
4	Cumulative soil evaporation during cover crop growing season	CC crop soil Evp.	mm (inches)
5	Cumulative soil drainage during main crop growing season	MC Wat Drain	mm (inches)
6	Cumulative soil drainage during cover crop growing season	CC Wat Drain	mm (inches)
7	Cumulative N leached during cover crop growing season	MC N Leach	Kg[N]/ha (lb [N]/ac)
8	Cumulative N leached during cover crop growing season	CC N Leach	Kg [N]/ha (lb [N]/ac)
9	Total Organic Carbon in Soil profile at the end of simulation period	Soil Org C	Kg/ha (lb/ac)

Table 2: Description of simulated parameters available for analysis and display in CCDSS.

Users can click on parameters in the summary table on the Results page to find descriptions and further details about these parameters.

3.4.2. Accessing Results

Results from simulations are displayed on the "Results" page, accessible directly from the CCDSS interface. This page lists all completed simulations, organized by the names you assigned during the General Information entry phase (Figure 7).

When you check the boxes for any simulations, the system displays metadata for each selected simulation under the “Selected Treatments” section below the list of completed simulations. The metadata includes the Name, Length of Simulation in years, Simulation Start Date (MM-DD-YYYY), Main Crop Type, and Cover Crop Species. Users can select up to four simulations to compare, and the metadata for these simulations will be displayed simultaneously, allowing for an effective comparison of different management strategies (see Figure 7).

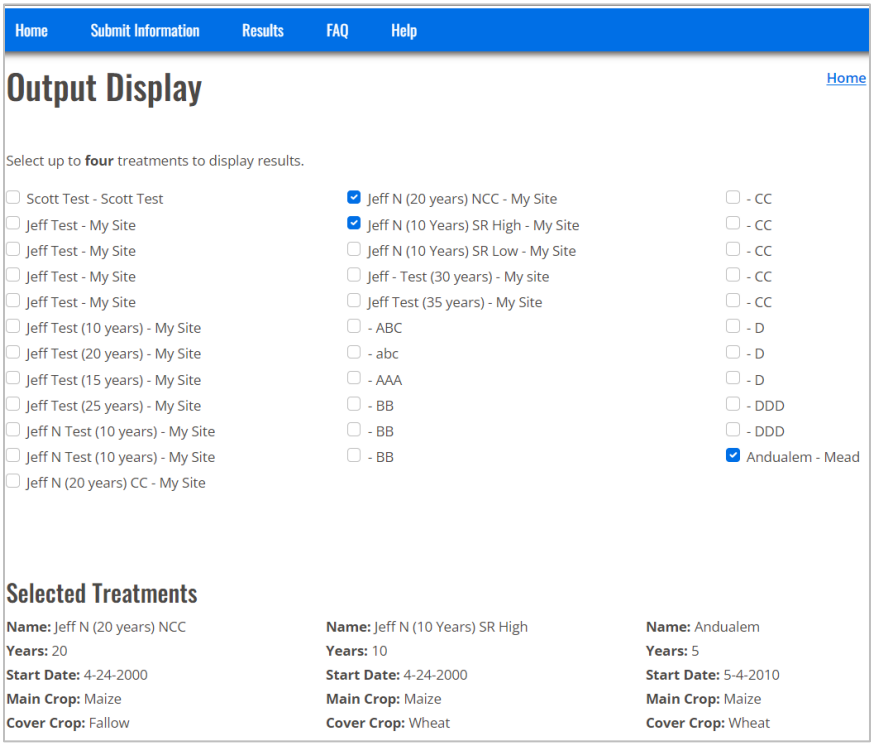


Figure 7: List of completed simulations under "Result" page.

3.4.3. Displaying Results

Users can view simulation results in three different formats, depending on their analytical needs: bar graphs, time series plots, and summary tables. After selecting one or more simulations for display, users can choose a parameter to visualize from the "Output to Display" dropdown menu located in the tab. There is also an option to select units, either "Metric" or "English," for the parameter being displayed.

Bar Graph

- **Overview:** The bar graph displays the average values of the selected parameter over the duration of the simulation. This format is useful for comparing the effects of different management practices across up to four simulations.
- **Example Use**: For instance, users can compare the impact of four different cover crop termination dates on cover crop biomass or main crop yield.
- **Interactive Features**: Each bar in the graph is labeled with the simulation ID. Users can click on a simulation ID in the legend to toggle the display of that particular simulation's data on or off.

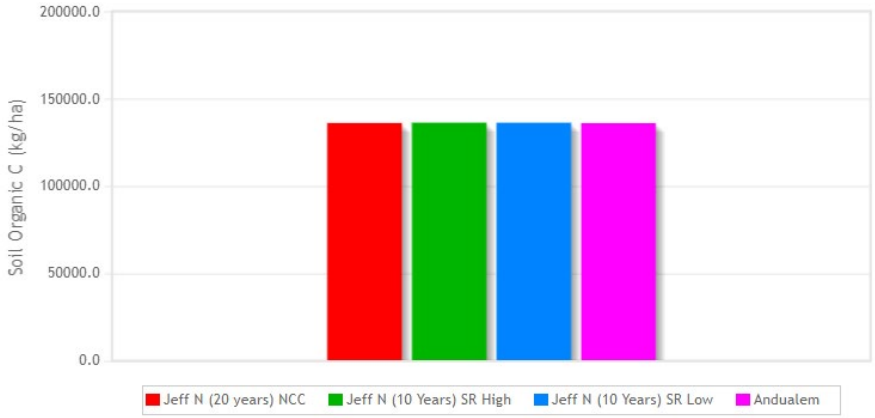
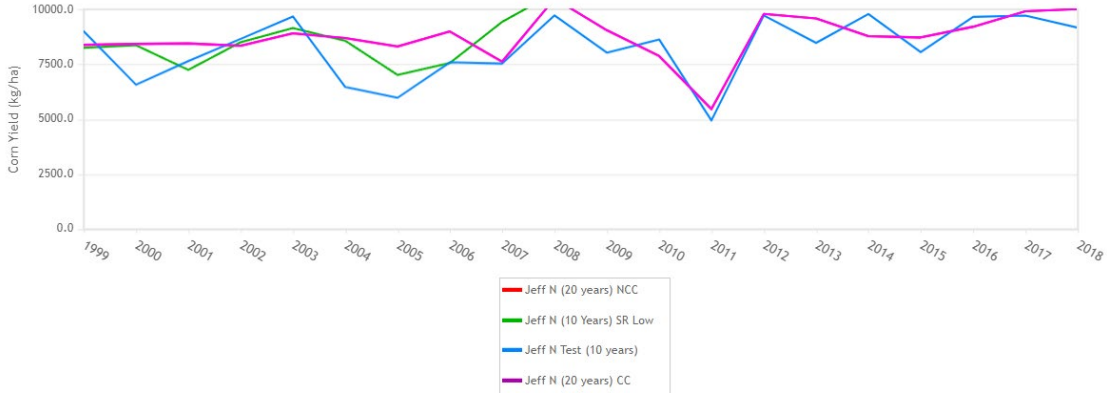


Table 3: An example of bar graph comparing soil organic carbon from four different simulations

Time Series Plot

- **Overview**: This plot shows the yearly trend and variation in the selected parameter throughout the entire simulation length. It allows for the detailed tracking of changes over time, accommodating comparisons of up to four different simulations.
- **Example Use**: Users might evaluate the long-term impact of using a cover crop on soil organic carbon accumulation and compare it to a no-cover-crop scenario.



Table

- **Overview**: The table provides a summary of all available parameters, averaged over the simulation period. However, for soil organic carbon, the value displayed is from the last year of the simulation.
- **Detailing**: If multiple simulations are selected for comparison, the table organizes the data such that each row represents a single simulation, identified by the Simulation ID under the 'Treatment' column (first column).

Table

Treatment	Corn Yld (kg/ha)	CC Biom (kg/ha)	MC Soil Evp (mm)	CC Soil Evp (mm)	MC Wat Drain (mm)	CC Wat Drain (mm)	MC N Leach (kg/ha)	CC N Leach (kg/ha)	Soil Org C (kg/ha)
Jeff N (20 years) NCC	8708.9	0.0	290.1	709.1	3.8	3.5	0.0	0.0	136233.0
Jeff N (10 Years) SR High	7706.0	818.3	279.1	657.2	2.9	2.7	0.0	0.0	136421.0
Andualem	10654.8	1328.6	225.2	682.0	9.2	6.0	0.0	0.0	136159.0

4. Future Developments:

Outlining upcoming features and enhancements planned for CCDSS, setting expectations, and potentially soliciting user feedback for future updates.

References:

Koo, Jawoo; Dimes, John, 2013, HC27 Generic Soil Profile Database, https://doi.org/10.7910/DVN/90WJ9W, Harvard Dataverse, V5.