# ISA 2023/24 Research Project
## Estimating crop yields and carbon intensities from earlier planted soybeans and potential synergies with partial corn residue harvest
Update Report by Salin 247, Inc.

for the

## Iowa Soybean Association
April 1, 2024

**Project objectives**

The primary objectives of the "**Estimating crop yields and carbon intensities from earlier planted soybeans and potential synergies with partial corn residue harvest**" project are to (1) evaluate the soybean yield and soybean carbon intensity (CI) impact of planting soybeans early in the spring, (2) evaluate the impact of corn stover partial removal prior to soybean planting on the soil suitability for planting and on soybean yield and soybean CI values, (3) complete an economic evaluation of early-planted, soybeans under the two corn stover management options, (4) evaluate the performance (e.g., acres planted per day, energy use, navigation performance) of an autonomous Salin 247 planter, (5) conduct the trials on actual Iowa farm fields, and (6) communicate the project results to the Iowa soybean industry.

**Summary of project progress**

- The original plan was to build and use for the project an 8-row autonomous planter. Instead, a second 4-row (30" row spacing) planter (V3) has been built. Based on learnings from last season, the new machine has several enhancements compared to the planter (V2) last season. Both 4-row planters will be used for the project
- Verbio agreed to help find project fields, and they provided a list of candidate growers, but none of those options worked out
- Several candidate growers/fields were tentatively enrolled in the project last fall but four of those options ultimately did not work out
- There was an original goal of six fields. Nine fields have been selected with an average size of 22 acres
- Four of the nine fields will have corn stover removal treatments
- Two of the nine fields have been strip-tilled
- Two of the nine fields will have fall and spring tillage
- One field has cover crops
- RTK GPS drone images have been taken and stitched for each of the nine fields
- Shape files of plot areas have been created in Ag Leader SMS software
- Project plots in fields have not yet been physically flagged but will get flagged in the next week or so
- Plot shape files have been sent to ISU so soil sampling can be scheduled and soil sensor installations can begin
- Planting details are being gathered from growers including desired planting population, number of end rows, how that are going to provide seed, and other information
- We will start the "early" planting as soon after April 1 that conditions are suitable. There is one grower that would not like us to plant prior to April 15, the FCIC's "earliest planting date" for northern Iowa.
- ISU will install soil sensors shortly before and shortly after planting.

**Salin 247 autonomous planters**

For the 2024 OFT project, Salin 247 will be using two autonomous, 4-row (30" row) planters (named V2 and V3). The planter (v2) used for last year's ISA project has been upgraded to address GPS and controller issues from last season. A new planter (V3) has been built with several upgrades including all-wheel steering (V2 is a skid steer machine), suspension system, telescoping toolbar, upgraded batteries, upgraded hydraulic system, and electronic improvements. Both planters will be using upgraded navigation software.

Salin 247 has also developed new path planning software. The software allows us to more efficiently and accurately create path plans for planting and for post-emerge operations. Our new approach requires that we obtain RTK GPS coordinates of each trial field. High resolution coordinates help improve the accuracy of navigation.

*Salin 247 planters ready to go to the field (V2 on left, V3 on right)*



**Status of project tasks**

The focus of work to-date has been on project planning. Below is the list of key project tasks along with a status update where applicable. Early planting of soybeans will begin as soon after April 1 that soil conditions are suitable (i.e., soil temps greater than 50 degrees Fahrenheit and around 35% soil moisture at planting depth), and the grower gives their approval. One grower does not want us to planter prior to April 15, the FCIC's earliest planting date to be eligible for replant seed cost coverage.

*Project task status as of April 1, 2024*

| Broad tasks | Key tasks | Description |
|---|---|---|
| Project planning and grower recruitment | Collaboration with ISA Research Center for Farm Innovation | Work with the RCFI on the details of an implementation plan including designing the trials and recruiting growers for the project<br>**Status: ISA agronomists worked to identify potential collaborative growers. Two growers were recruited for the project.** |
| | Collaborate with Verbio on finding growers | Verbio, a cellulosic energy producer in Neveda, IA, agreed to help us find collaborative growers for the project<br>**Status: Verbio was not able to recruit any growers for the project.** |

| Broad tasks | Key tasks | Description |
|---|---|---|
| | One-on-one conversations with potential collaborator growers | Identify a set of potential collaborative growers during the summer of 2023 and speak with them one-on-one about the trail protocols and expectations.  Get firm commitments from six growers and two to three backup growers prior to 2023 harvest.<br>**Status:  Commitments have been made by 8 growers for 9 trial fields (one grower will have 2 plots).** |
| 2023 fall field work | Arrange for corn stover removal on collaborative farm fields | Make arrangements for custom corn stover removal on designated areas of collaborative farm fields and at specified removal rates<br>**Status:  We did not need to do any corn stover removal in the fall.  Selected growers already had done removals.** |
| | Conduct corn stover removal | Complete the corn stover removal and transportation to market<br>**Status:  Stover removal not needed last fall.** |
| Planter design, construction, & testing | Planter design | Based on learnings from past and current ISA-funded projects, Salin 247 has concluded that a 20-foot toolbar planter (i.e., 8 30" rows) has economic advantages over a 10-foot planter toolbar (i.e., 4 30" rows).  Significant design changes and a different energy management approach are needed to accommodate a 20-foot planter toolbar.<br>**Status:  Instead of building an 8-row planter, two 4-row planters will be used.** |
| | Planter construction | Source components needed for the 20-foot planter toolbar and construct an 8 30" row autonomous planter that will plant at 5.5 mph (i.e., plant at ~10 acres per hour)<br>**Status:  The second 4-row planter has been built and is being tested.  The new planter has many enhancements based on learnings from last season.** |
| | Planter testing | Prior to starting project planting, conduct appropriate testing in the shop and in the Salin 247 test field<br>**Status:  Field testing of both planters is still underway as of 4/1/2024.** |
| 2024 spring work | Obtain high resolution field boundaries & field maps & create navigation paths | Using a drone with RTK GPS and a high resolution camera, capture high resolution field images<br>Stitch images into one high-resolution field map.<br>Identify project plot area for each field<br>Generate navigation paths for planting<br>Create shape files for plot areas and for the navigation paths<br>Define early planted and late planted areas of the plots<br>**Status: High resolution field maps have been created for each of the nine project fields.  Plot areas have been identified.  Not all early and late areas have been identified yet** |
| | Soil testing | ISU plans to take soil samples on selected fields.<br>**Status: Soil samples have not yet been taken, but the plan is to take them prior to planting.  ISU will schedule this task.** |
| | Install soil temperature and moisture sensors | Soil temperature and moisture sensors will be installed.  Iowa State University will select the appropriate sensors to be used<br>**Status:  Iowa State has ordered and received 72 soil sensors.  They will be installed shortly before or shortly after planting.  ISU wants to install the sensors on 3 project fields.** |
| | Soil temperature and moisture data collection | Weekly soil temperature and moisture data for all 24 treatments will be begin in early spring and continue through the growing season |
| | Early-season planting | Soybeans will be planted on half of each of the six cooperator fields early in the season (as soon as soil moisture conditions allow) |

| Broad tasks | Key tasks | Description |
|---|---|---|
|  | Later-season planting | Soybeans will be planted on the other half of the six fields at least 14 days past the early-season planting date for each respective field |
|  | Planter performance data collection | Planter performance data (e.g., acres planted per hour, energy use, navigation accuracy) will be collected during planting |
| 2024 growing season work | Soil nitrate nitrogen data collection | Weekly soil nitrate nitrogen levels will be collected for each of the 24 treatments starting one to two weeks prior to planting and extending through the growing season |
|  | Weather data collection | Temperature and rainfall data will be collected throughout the growing season.  Temperature data will come from the closest weather reporting site, and rainfall data will come from Climate Corporation reported rainfall estimates by field **Status:  Climate Corporation data collection will begin April 1.** |
| 2024 fall work | Crop yield data collection | Cooperator growers will collect yield monitor data and provide it via a designated data format |
| Modeling, data analysis and project communications | Data management and analysis | Complete the collection and cleaning of all field data and complete the data analysis for the project |
|  | Semi-annual reporting | Provide two updates via the ISA semi-annual reporting process |
|  | Field day | A field day will be scheduled for the summer of 2024 to provide an update on the project and report planting performance findings |
|  | Final report | A final report of project findings will be prepared and provided to the ISA once all harvest data has been collected and the data analysis completed by December 2024 |
|  |  |  |

## Trial fields

Below is a table listing the nine project fields.  These nine fields are being provided by eight different growers.  Note that one of the "growers" (Field 1) is Iowa State University.

2024 Early Planted Soybean Project Fields

| Field | Field location | Approx. acres | Tillage | Stover status | Area of 50% stover removal | Area of early planting | Drone images | Field boundary shape file | Early planting date | Late planting date |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SW corner 300th & Violet | 18 | Strip-till | 0% removal | None | TBD | Yes | Yes | TBD | TBD |
| 2 | Half mile north of 160th & 730th Ave | 20 | No-till | 0%/50% removal | South half | TBD | Yes | Yes | TBD | TBD |
| 3 | NE corner of 300th & Highway 169 | 18 | No-till | 0%/50% removal | South half | TBD | Yes | Yes | TBD | TBD |
| 4 | NE corner of 300th & Highway 169 | 18 | No-till | 0%/50% removal | South half | TBD | Yes | Yes | TBD | TBD |
| 5 | NW corner 120th & Quail Ave | 20 | No-till | 0%/50% removal | West half | TBD | Yes | Yes | TBD | TBD |
| 6 | SE corner 260th & 650th Ave | 18 | Strip-till | 50% removal | All | TBD | Yes | Yes | TBD | TBD |
| 7 | NW corner 280th & 730th Ave | 27 | No-till | 50% removal | All | TBD | Yes | Yes | TBD | TBD |
| 8 | SW corner 400th & 580th Ave | 18 | Fall rip, spring FC | 0% removal | None | TBD | Yes | Yes | TBD | TBD |
| 9 | Half mile east of 250th & U Ave | 40 | Fall rip, spring FC | 0% removal | None | TBD | Yes | Yes | TBD | TBD |
|  |  | **197** |  |  |  |  |  |  |  |  |

The original aim was to find six no-till fields where half of the field would have 50% residue removal.  We were able to identify seven no-till fields but only five had an option to do 50% residue removal.  Recently we learned that strip-till was done on two of the fields (Field 1 & 6).  We were planning to do residue removal on one of those fields, but it was determined not to be feasible.  The table below provides some useful information on the nine project fields.  All the fields grew corn in 2023.

**Field trial design**

Below is a depiction of the original field trial design with two planting date treatments ("Early planted" and "Late planted") as well as two corn stover removal treatments ("No fall stover removal" and "50% fall stover removal"). The size of plots is going to be determined by the size and shape of the selected fields.

*Original field trial design*
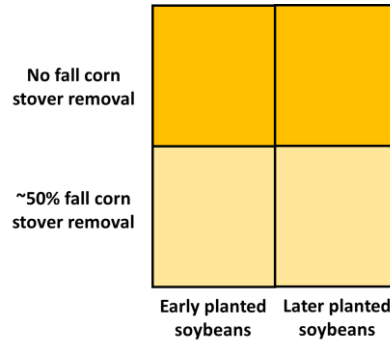


Note that two of the fields with residue removal needed an alternative design. Their design is shown below.
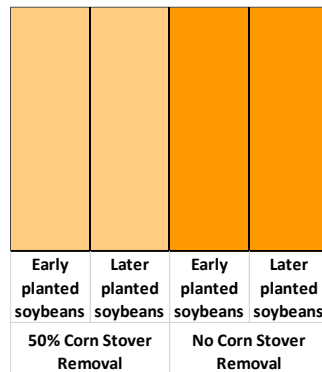


**Planting schedule**

The goal is to begin planting the "early" treatments as soon as soil conditions are suitable but after April 1. The timing of planting for any given field will also depend on the timing of pre-plant herbicide applications by the growers and by cover crop termination for fields that planted cover crops last fall. Planting could also be impacted by soil sampling scheduling.

**Planter logistics**

For most of the project fields, our plan is to operate both of our 4-row (30" row spacing) autonomous planters. This will require leasing a pickup and flatbed trailer.

Some growers would like to provide us seed in bulk but not have to tie up their seed tender. For those growers, we will have a bulk box where grower seed can be put prior to going to the field.

**Data collection**

Iowa State University is wanting to install soil sensors on three of the project fields. A total of 72 soil sensors are available. The sensors will be logging soil temperature, moisture, and other data several times each day.