# Soybean Variable Rate Seeding Simulator

# <u>User Manual</u>

<b>IOWA SOYBEAN</b> Association	Membership	Programs	Newsrool 1	Research	Events About						
About RCFI	Results of Our Work			About RCFI Work With	Us						
Work With Us	ISA's Research Center for Farming Innovation is taking on-farm research c 2 Results & Tools										
Resources & Publications	involved with ISA and learn about tools th	at can save you ti	ime and strengthe	Resources Research N	& Publications						
Research News	Put our tools and services to work in your provides access to the association's robus	fields by participa t database which	ating in <b>on-farm re</b> includes research	Innovation Conference	to Profit						
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	+ Interactive Summaries of On-Farm Strip Trials: ISOFAST										
	+ Vegetation Index Time Series	Interactive To	ol: VITSIT								
3	— Soybean Variable Rate Plantin										
	Before flying solo, student pilots use whether to use soybean variable rat and expected yield response, the to return and minimize cost.	e a flight simulato e seeding? With ol simulates diffe	or. Why not use a si user inputs of histo rent variable planti	milar approach v vrical soybean yie ng rate scenario:	when deciding eld, seed cost, s to maximize						
	4 Launch VRP Simulator	Or watch a "Ho	w To video" for th	is tool.							
	View the user manual here.										

Figure 1. Accessing the Simulator on Iowa Soybean Association website.

## Accessing the Simulator

Go to the Iowa Soybean Association website.

www.iasoybeans.com

Select Research -> Results & Tools -> in the Results of Our Work section find -> Soybean Variable Rate Seeding Simulator and then click the blue "Launch VRS Simulator" button.

You will then be redirected to: analytics.iasoybeans.com/coolapps/SoybeanVRPsimulator/

# Uploading & Aggregating Yield Data

**NOTE:** Sample data is pre-loaded in the simulator. In order to process data for their own fields, users must have access to three, individual years of geo-spatial soybean yield data for the same

field in shape file format (.shp, .shx, .dbf, .prj), which can be exported from applications such as AgLeader SMS, MyJohnDeere or other yield collecting or processing software. Label each of the three shape files including the crop year. Place all three years of yield data into a single folder and "Zip" the file, by right clicking on the folder > send to > compressed zipped folder. Note: the yield maps included in the zip file must be projected in World Geodetic System 1984 (EPSG: 4326 - WGS84) as spatial reference system.

Soybean Variable Rate Seeding Simulator	Historical Yield Upload	Aggregated Yield	Seeding Rate Assignment	Cost and Return Analysis	Break-Even Analysis	User Manual
Configuration Your shapefile data must be uploaded as a single .zip file, with three years of yield data included. Data Source Example Data • Layer (Year 1) Year2_Example • Layer (Year 2) Year3_Example • Layer (Year 3) Year1_Example • Yield Categories Yield Categories Yield Level • Show Advanced Options	• 3 year • ISA is • Data a • Data a	s of po not co ire only ire pro	oint shape llecting y y loaded cessed o	e files fro our data on your online, no	om SMS ; comput ot savec	S ter 1

Figure 2. Upload interface for historical yield data.

By default, the tool automatically displays an example using an anonymous field for illustration purposes (Figure 2) that allows users to explore the tool features and usability without first requiring an upload of the user's own yield data.

To Preserve data privacy, the tool does not collect or store any yield or spatial coordinates from user files, but simply processes data "on-the-fly", meaning that when you exit the application, your data exits with you. To view it in the application again, it will be necessary to upload it again.

Configuration					
Your shapefile data must be uploaded as a single .zip file, with three years of yield data included.					
Data Source					
Example Data					
Example Data					
Upload Data					

**Step 1.** On the left side navigation panel, click on the "Example Data" dropdown and select "Upload Data". An upload button will appear.

Shape File (3 Years)					
Upload	No file selected				

Click the red "Upload" button to navigate to and select the zipped folder containing your yield files, then click "Open"

The tool will then begin uploading the yield data.

The bar below "Browse..." will indicate when the Upload is complete

Step 2. Once upload is complete, select "Aggregate"

A popup box in the bottom right corner will appear indicating that aggregation is occurring. When finished, the raw and aggregated yield data will appear.

**Optional.** Show Advanced Options

The user can adjust the grid size and number of points within each grid.

#### Step 3. Yield Categories

**Yield Level**: Selecting this option will group the aggregated yield data into three absolute yield categories based on average Iowa statewide soybean yield (USDA-NASS, 2020).

Low (Less than 52 bu/ac) Medium (52-63 bu/ac) High (greater than 63 bu/ac)

**Yield Stability Zone:** Selecting this will group the aggregated yield data in categories Q1, Q2, Q3, and Q4 which are determined by the average yield relative to the whole-field yield and its temporal standard deviation(SD) relative to the field average temporal standard deviation based on the Kharel et al., 2019 method.

Q1: below mean yield and below mean SD, Low Yield, Stable

Q2: below mean yield and above mean SD, Low Yield, Unstable

Q3: above mean yield and above mean SD, High Yield, Unstable

Q4: above mean yield and below mean SD, High Yield, Stable

Click on the "Aggregated Yield" tab in the navigation bar at the top of the application to view the compiled yield data. From this tab you can also export a csv file of the aggregated data from the field.



Figure 3. Aggregation of historical yield data using yield level option: low, medium, and high.

Soybean Variable Rate Seeding Sim	ator Historical Yield Upload Aggregated Yield Seeding Rate Assignment Cost and Return Analysis Break-Even Analysis User Manual
Configuration Your shapefile data must be uploaded as a single .zip file, with three years of yield data included. Data Source Example Data Layer (Year 1) Year2_Example	Aggregated Yield (year 1) Aggregated Yield (year 2) Aggregated Yield (year 3)
Layer (Year 2) Year3_Example 👻	Productivity Zones
Layer (Year 3) Year1_Example	
Yield Stability Zones	Yield Category         Low Yield, Stable (mean=51.3 bu/ac)         Low Yield, Unstable (mean=57.6 bu/ac)         High Yield, Unstable (mean=57.4 bu/ac)         High Yield, Stable (mean=57.4 bu/ac)
Aggregate     Show Advanced Options	

**Figure 4.** Aggregation of historical yield data using the yield stability zone option: Low Yield Unstable, Low Yield Stable, High Yield Unstable and High Yield Stable.

## Aggregated Yield

**Export Aggregated Data:** There is an option to export the generated aggregated map as a .csv file. Exported headings include: Grid ID, X & Y coordinates, Yield, Yield SD, and Yield Group. This allows the user to conduct additional analyses outside the scope of this simulator.

## Seeding Rate Assignment (sd/ac)

#### Step 4. Select the seeding rate Assignment tab in the top menu bar

There are three Common Uniform Seeding Rate (CUSR) data sources to **choose** from:

1) ISU Data Source

This data source allocates seeding rate recommendations according to Iowa cropping district. This data source applies recommendations from an Iowa State University published study, *DeBruin et al. 2008* 

2) Midwest Data Source

This data source applies recommendations from a midwestern seeding rate study, *Carciochi et al. 2019* 



**Figure 5.** Relationship between seed yield and plant density for low (LYE, <59.6 bu acre<sup>-1</sup>, A), medium (MYE, 59.6-64.1 bu acre<sup>-1</sup>, B), and high yield environments (HYE, >64.1 bu acre<sup>-1</sup>, C) from Carciochi et al., 2019 on-farm studies across Midwest, including Iowa.

3) User Defined

This data source employs a user indicated seeding rate. This is intended to be the common seeding rate that has been applied to this field in the past.

Soybe	an Variable Rate Planting Simulator	Historical `	Yield Upload	Aggregated Yield	Seeding Rate Assi	gnment	Cost & Return Analysis	Break-Even Analysis
1	Common Uniform Seeding Rate (CUSR)							
	ISU Data Source 🔻							
	Iowa Cropping District	2		n Uniform Seec	ling Rate			
	1,5 👻		(COSK)					
			Midwe	est Data Source	• •			
	Rate Chosen: 139000 sd/ac		Seeding	Rate		3	Common Uniform ( (CUSR)	Seeding Rate
			96500	)	-		User Defined	-
			Rate Ch	osen: 96500 sd	/ac		Seeding Rate	250.000
							80,000 140,000 200,000	260,000 320,000
							Rate Chosen: 1300	00 sd/ac

Figure 4. Options for selecting common uniform seeding rates.

Soybean Variable Rate Seeding	Simulator	Historical Yield Upload	Aggregated Yield	Seeding Rate Assignment	Cost and Return Analysis	Break-Even Analysis	User Manual
Common Uniform Seeding Rate (CUSR)	Export A	ggregated Data					
Midwest Data Source 👻	🛓 Expor	t SR Shapefile					
Current Seeding Rate (sd/ac)							
150000	Adjuste	d Seeding Rat	е Мар		1. S.		
Plant Density Conversion Factor				140 C	Maria .		
0.78				Same and the second	State of the state	Seeding Rate Category (sd/ac	.)
Current Planting Density (plants/ac): 117000						162821 (Low (<52 bu/ac)) 123077 (Medium (52-63 bu/ai 124359 (High (>63 bu/ac))	c))
Yield Category				the second s	Sec. 1		
Low (<52 bu/ac) 👻				Sec. Sec.	1 . L . Marine		
Seeding Rate Change (%)	Export	nd Viold Man					
-50 -38 -26 -14 -2 10 22 34 46 58 70	Expedit	eu neiu map			1 A 1		
Expected Yield Increase (%)					and the second se		
						Expected Yield Category Low (<52 bu/ac) Medium (52-63 bu/ac)	
Seeding Rate Recommended: 162821 sd/ac						<ul> <li>nign (&gt;63 bu/ac)</li> </ul>	
Target Plant Density: 127000 sd/ac							

**Figure 6.** Seeding rate assignment for Yield Level Classification using the Midwest Data Source (*Carciochi et al. 2019*).



**Figure 7.** Seeding rate assignment for Yield Stability Classification using the Midwest Data Source (*Carciochi et al. 2019*).

For the yield level classification, the recommendations are based on plant density targets of 127,000, 96,000, and 97,000 plants/acre, for Low, Medium, and High yield environments, respectively (*Carciochi et al. 2019*). For the yield stability classification, the recommendations are based on plant density targets of 127,000, and 97,000 plants/acre, for Low-Stable, and High-Stable yield environments, respectively; while a compromise solution of 112,000 plants/acre is recommended for both Low-Unstable, and High-Unstable yield environments

Variable rate seeding prescription can be exported using the Data Export option on the Seeding Rate Assignment Tab (Figure 6 and 7).

## Cost and Return Analysis

 Step 5. Input economic variables to run the cost and return analysis.
 Select which yield category to adjust seeding rates (Low, Medium or High) Input a grain price (\$/bu).
 Input seed cost per bag (140,000 seeds/bag)
 Seed cost per acre will be populated based on the cost per bag

## **Expected Yield Gain in Selected Yield Category**

- The simulator will calculate approximate field size.
- The simulator will calculate approximate size (ac) and average yield (bu/ac) of the selected yield category.

• Applying the economic variables, the simulator will calculate the expected yield gain or loss in the selected yield category.

## Additional Seed Cost

• The simulator will calculate the additional or reduced cost (ac) due to the adjusted seeding rate using the input seed cost and CUSR.

## Potential Profit for Selected Yield Category

• The simulator will subtract the Additional Seed Cost from the Expected Yield Gain in Selected Yield Category, then multiply by the total yield category area.

## Potential Profit for Whole Field

• The simulator calculates whole field profit per acre by dividing the Potential Profit for Selected Yield Category by the whole field area.

Soybean Variable Rate See	eding Simulator	Historical Yield Upload	Aggregated Yield	Seeding Rate Assignment	Cost and Return Analysis	Break-Even Analysis	User Manual		
Grain Price (\$/bu) \$14.00 Seed Cost per bag (\$/140,000 seeds) \$57.00 Seed Cost (\$/ac): \$61.07	Yield Gain in S Your field is approxit low yield category a 1.47°514.00 = \$20.5 medium yield category 0°514.00 = \$0.00/ac	Selected Category mately 16 acres. veraged 49 bu/ac and was 4 ac 8/ac ory averaged 56 bu/ac and was averaged 66 bu/ac and was 0 ac	res of the field. Assumi 12 acres of the field. As cres of the field. Assumi The adjusted ser	ng +3.0% yield increase or 1 bu/ac isuming +0.0% yield increase or 0 ng +0.0% yield increase or 0 bu/a eding rate in the low yield areas	yield increase or 1 bu/ac with adjusted seeding rate = 49*0.03=1.47 bu/ac. Total Economic Gain = +0.0% yield increase or 0 bu/ac with adjusted seeding rate = 56*0=0 bu/ac. Total Economic Gain = 6 yield increase or 0 bu/ac with adjusted seeding rate = 66*0=0 bu/ac. Total Economic Gain = 0*\$14.0 ====================================				
Return for Yield Catego	<u>rries</u> eturn increase in lo	w vielding areas, or tota	150000*1.08547 The adjusted set 150000*0.82051 The adjusted set 150000*0.82905	008547009=162,821sd/ac. At a eding rate in the medium yield a 2820512821=123,077sd/ac. At dilng rate in the high yield area 9829059829=124,359sd/ac. At	seed cost of \$61.07, extra set areas is -17.95% a seed cost of \$61.07, extra se is is -17.09% a seed cost of \$61.07, extra se	ed cost is \$56.29 - \$61.07 eed cost is \$50.11 - \$61.0 eed cost is \$50.63 - \$61.0	= \$5.22/ac 7 = -\$10.96/ac 7 = -\$10.44/ac		
\$0.00\$10.96 = \$10.96/ac \$0.00\$10.44 = \$10.44/ac	return increase in m return increase in hi	igh yielding areas. or to	r total \$10.96*12= tal \$10.44*0= <b>\$2.0</b> 4	\$130.15 With an overall exper- with an overall exper- with an overall exper- tional Profit Per Field Total Profit Per Access	field Categories cted profit of \$60.37, the expected p cted profit of \$130.15, the expected cted profit of \$2.04, the expected pr \$192.57 \$12.04	orofit per acre for low yield are profit per acre for medium yie ofit per acre for high yield are	eas is \$3.77. eld areas is \$8.13. as is \$0.13.		

Figure 8. Example of Cost and Return Analysis

#### **Break-Even Analysis**

This analysis indicates the minimum return necessary to pay for using variable rate technology.

**Step 6.** Adjust economic variables:

Enter soybean grain price (\$/bu)
Enter costs associated with using variable rate seeding technology
Add an item for each cost: Equipment, hardware, software, time, Rx development, advisor
Enter total estimated cost of soybean production, *excluding* seed costs.

# Note: This will default using ISU estimates

## **Break-Even Yield Response**

• The simulator will indicate the needed yield increase to justify the additional cost associated with variable rate seeding.

#### **Break-Even Soybean Cost or Price**

• The simulator will calculate the necessary soybean price to cover the cost of variable rate seeding and total production costs.

Soybean Variable Rate Seeding Simulator	Historical Yield Upload	Aggregated Yield	Seeding Rate Assignment	Cost and Return Analysis	Break-Even Analysis	User Manual
Soybean Price (/bu) \$14.00 Add Variable Rote Cost Rem 1 Cost (/ac) VRT Equipment Costs \$2 Total Soybean Production Cost (excl. seeds) \$550.00	Break-even With extra se With extra se With extra se	yield respon ed cost of \$61.07 ed cost of \$61.07 ed cost of \$61.07	<mark>SE (Yield Increase</mark> '/ac, a Break-Even Yield I '/ac, a Break-Even Yield I	Needed to Cove Response for low yield Response for medium y Response for high yield	er the Cost Ext areas is 0.52 bushel yield areas is -0.64 b d areas is -0.6 bushel	<u>ra Seeds)</u> s. ushels. s.
Break-Even Soybean Price (Price With the extra cost of \$7.22/ac in seeds, ar \$11.06/bu. With the extra cost of -\$8.96/ac in seeds, a areas is \$9.64/bu. With the extra cost of -\$8.44/ac in seeds, a is \$8.17/bu.	ce of Soybean to ad yield increase 3.0% nd yield increase 0.0% nd yield increase 0.0%	D Cover the ( , and cost of soyl %, and cost of soy %, and cost of soy	Cost of Extra See bean production \$550.0 rbean production \$550.0 rbean production \$550.0	d and Total Produ 0/ac, the break-even So 00/ac, the break-even S 00/ac, the break-even S	uction Cost) oybean price for low Soybean price for me Soybean price for hi <u>c</u>	yield areas is dium yield ıh yield areas

Figure 8. Example of Break-Even Analysis

## Simulator Value

Simulation-based decisions can be a way for farmers and advising agronomists to build knowledge and skills while not exposing their customers, farm, or crop to any unnecessary risks. Simulation-based scenarios can be a platform which provides a valuable tool in learning to mitigate economic and practical dilemmas. Simulation-based training techniques, tools, and strategies can be applied in designing learning modules, as well as be used as a measurement tool to establish realistic economic and agronomic objectives and outcomes.

## **References:**

Carciochi, W.D., Schwalbert, R., Andrade, F.H., Corassa, G.M., Carter, P., Gaspar, A.P., Schmidt, J. & Ciampitti, I.A. (2019), Soybean Seed Yield Response to Plant Density by Yield Environment in North America. *Agron. J.*, 111: 1923-1932. <u>https://doi.org/10.2134/agronj2018.10.0635</u>