SCSB Final Report

General Information
Principal Investigator(s) Name(s): Kendall R. Kirk
Organization: Clemson University
Date: January 8, 2019
Quarter: Final

Proposal Information
Title: Variable Rate Soybean Seeding: On-Farm Tests
Amount Expended to Date: $5000

Project Summary
This study sought to evaluate the profitability of variable rate seeding for soybean and to work towards development of recommendations for variable rate prescription development. Three fields across S.C. soybean producing areas (Newberry, Allendale, and Lee counties) were planted with several different uniform seeding rate strips. The seeding rates selected were centered on each grower's normal seeding rate. Soil texture and organic matter maps were developed for all three fields and a soil electrical conductivity map was acquired for one of the fields.

The "Directed R_X" process was used for evaluation of seeding rates involved, assessing yield as a function of soil characteristic (e.g., sand content) for each seeding rate tested. Assuming a price of $10/bu and a seed cost of $60/bag, returns above variable input costs (RAVIC, $/ac) were calculated for each yield data point. The seeding rate prescription was determined from the results as the seeding rate within each soil classification, or zone, at which RAVIC was maximized.

At the irrigated, Allendale County site, P55T51RR (group 5) soybean was planted on April 17, 2018 at seeding rates of 100k, 110k, 120k, 130k, and 140k seeds per acre; harvest took place on October 5. Row spacing was 30 in. and each rate was planted in 12 row strips. Figure 1 shows RAVIC vs. Shallow EC for the field, demonstrating that the 120k seeds per acre rate was the most profitable seeding rate across all shallow soil EC zones and demonstrating that there was no benefit from variable rate seeding for this field, variety, and crop year. RAVIC was low across all seeding rates in the lightest soils and increased to a plateau in the light-to-mid-textured soils.

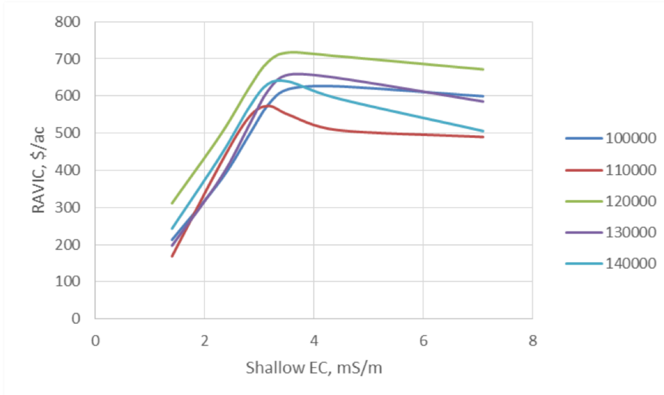
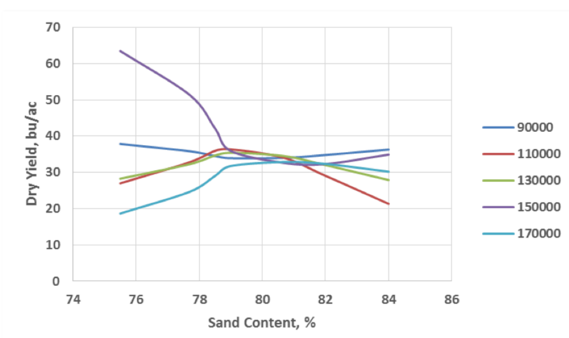


Figure 1. Returns above variable input costs vs. shallow soil EC for Allendale County test site.

At the non-irrigated, Newberry County site, Asgrow 59X7 was planted on May 24, 2018 and harvested on October 31. Seeding rates applied were roughly 90k, 110k, 130k, 150k, and 170k seeds per acre; row spacing was 15 in. Figure 2a shows RAVIC vs. sand content across all seeding rates tested. The data suggest that a variable rate seeding plan to maximize profit would be represented by a high seeding rate (150k seeds per acre) in the heaviest soil in the field and transition to a lower seeding rate (90k seeds per acre) in the lightest soil, as shown in Figure 2b. The most profitable uniform seeding rate tested was 150k seeds per acre, demonstrating a RAVIC of $353.9/ac and a yield of 41.8 bu/ac. Analysis of the data suggests that application of the Directed R_X shown in Figure 2b would have resulted in an average RAVIC of $375.5/ac and an average yield of 42.6 bu/ac, representing potential estimated benefit from variable seeding equal to $21.6/ac and 0.8 bu/ac. The profit benefit exceeds the product of price and yield benefit due to seed cost savings at lower seeding rates.



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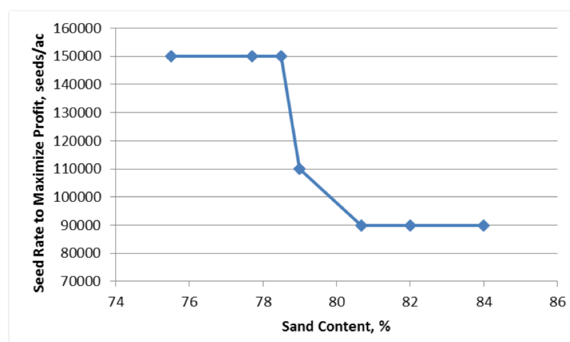


b

Figure 2. Returns above variable input costs vs. sand content (a) and Directed R_X, or seeding rate to maximize profitability as a function of sand content (b) for Newberry County test site.

At the non-irrigated, Lee County site, a group 7 soybean was planted around early June but at the time of reporting, harvest data had not been collected yet. Target seeding rates applied were 100k, 120k, 140k, 160k, and 180k seeds per acre. This report will be updated and delivered to the SC Soybean Board once the data becomes available.
Combining the four site years of yield data from variable rate soybean seeding tests allows for RAVIC to be plotted as a function of seeding rate tested, partitioned out by soil characteristic.

Soil EC cannot be used for grouping the data because it is a relative measure and could vary in the same position at different soil moisture contents, for example if the data were mapped on different dates. Soil texture is an absolute measure of soil variability and was used for grouping the RAVIC data, with one data point generated for each yield data point. Second order polynomial curves were fitted to these plots, an example of which is shown in Figure 3.

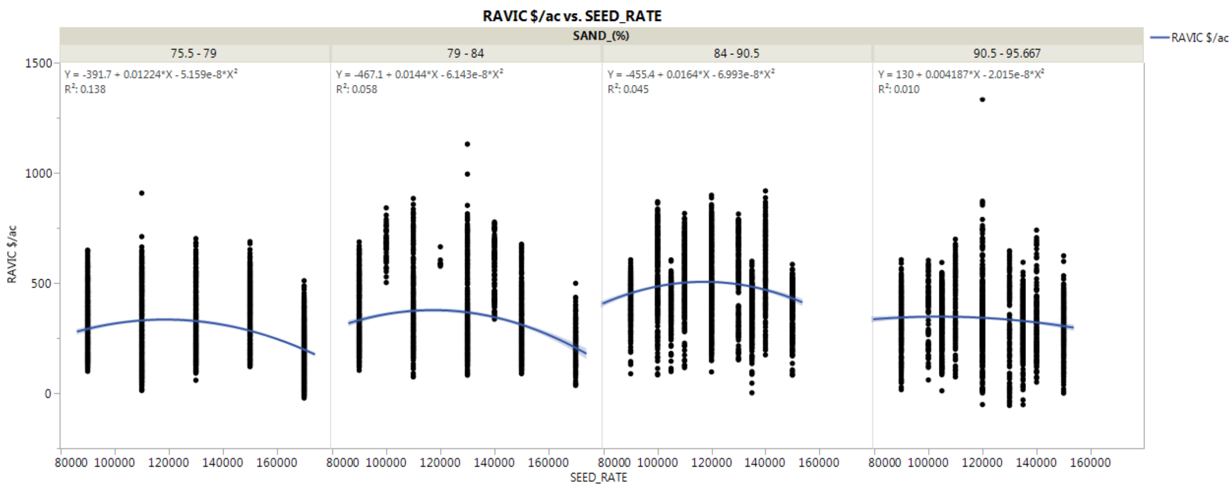


Figure 3. RAVIC ($/ac) as a function of seeding rate by soil texture grouping.

Although the correlations between second order polynomial functions and the data shown in Figure 3 are relatively weak ($R^2 < 0.138$), they provide a generalized starting point for selection of seeding rate to maximize profit as a function of soil texture. Solving the first derivative of the models in Figure 3 for zero gives the seeding rate at which RAVIC is maximized for each sand content grouping. This same modelling was conducted across several additional groupings of sand content and seeding rate to maximize profit was calculated for each, generating a summary of the pooled dataset, which is shown in Figure 4 giving seeding rate to maximize profit as a function of sand content. It must be stressed that the relationships used to generate this figure were relatively weak and highly generalized, although the function provided in the figure may still be useful to very generally guide SC soybean growers in making variable seeding rate prescriptions for their fields. In the function provided, given a known sand content, generalized seeding rate to maximize profit can be calculated. For example, seeding rate to maximize profit at a sand content of 91% would be calculated as: $-100.35*(91)^2 + 16231*(91) - 536020 = 110{,}003$ seeds per acre. It is the opinion of the Clemson Precision Agriculture group, however, that the current best practice in making a variable rate seeding prescription for soybean must include a test such as that outlined in our Directed R_X method. Our studies have shown that specific varietal and field effects will dictate different yield responses to seeding rate on a field by field basis. If any growers with yield monitors are interested in guidance in conducting such tests, we would gladly assist them.

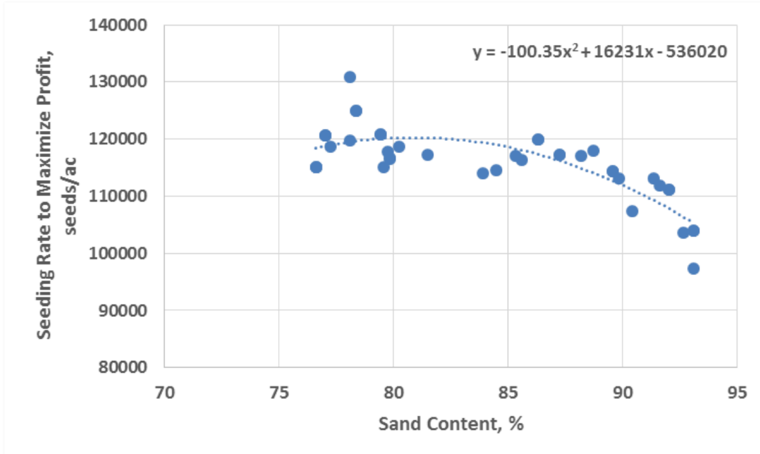


Figure 4. Generalized seeding rate to maximize profit as a function of sand content for pooled dataset including all yield data for four site years.

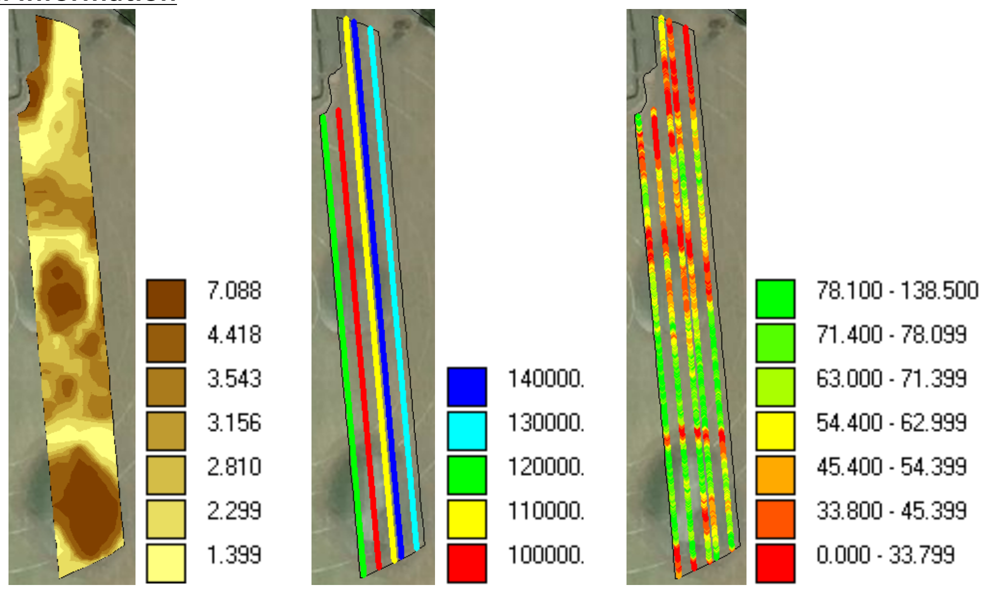
Key Performance Indicators

- Variable rate soybean seeding was demonstrated to have potential for profitability in three out of four site years of testing: one of the two sites evaluated in 2018, and both of the site years for the tests conducted at Edisto REC in 2016 and 2017.
- In two out of the three site years where variable rate seeding was indicated to be profitable, the prescription to optimize profit was characterized as higher seeding rates in the heavier ground, transitioning to lower seeding rates in the lighter ground, generally being centered on the grower's preferred seeding rate with a range of about 50k seeds per acre from the low rate to the high rate.
- At one of the sites supported by these studies, the prescription developed in Year 1 was applied in Year 2, demonstrating a profit benefit of $3.4/ac. Potential variable rate soybean seeding benefit across all four site years evaluated to date averages $9.9/ac. It must be recognized that this potential benefit represents the benefit that would have been achieved if the prescription was precisely that combination of seeding rates as a function of soil classification that maximized profitability.
- Using the pooled dataset from four site years of tests, a highly generalized model has been developed to select seeding rate to maximize profitability as a function of sand content, although field by field testing would almost certainly produce more profitable prescriptions for SC soybean growers. The function is: [Seed Rate to Maximize Profit] = -100.35*[Sand Content]^2 + 16231*[Sand Content] – 536020.
- The strip trial methodology for developing the Directed R_X can benefit growers regardless of whether or not variable rate seeding proves to be profitable because it still demonstrates to them the uniform seeding rates that are most profitable; it is an excellent way for growers to put their yield monitor data to work in improving their management decisions.

Next Steps

The findings of this project have already been presented at several field days, in the Clemson Precision Agriculture Newsletter, at a CCA training workshop, and at an international agricultural engineering meeting. We plan to continue to investigate the mechanisms that dictate most profitable seeding rates and to assess the profitability of variable rate soybean seeding, hopefully developing more certain and rigorous guidelines than those that have been described here from four site years of work. Ultimately, more data is necessary to make good, sound recommendations. That said, the SC Soybean Board has indicated in a document accompanying the 2019 request for proposals that they do not wish to fund additional research in soybean seeding rate so a continuation of this funding will not be requested.

Additional Information



(a) (b) (c)

Figure 5. Shallow soil EC map (a, mS/m), planting map (b, seeds/ac), and yield map (c, bu/ac) for the 2018 Allendale County site.

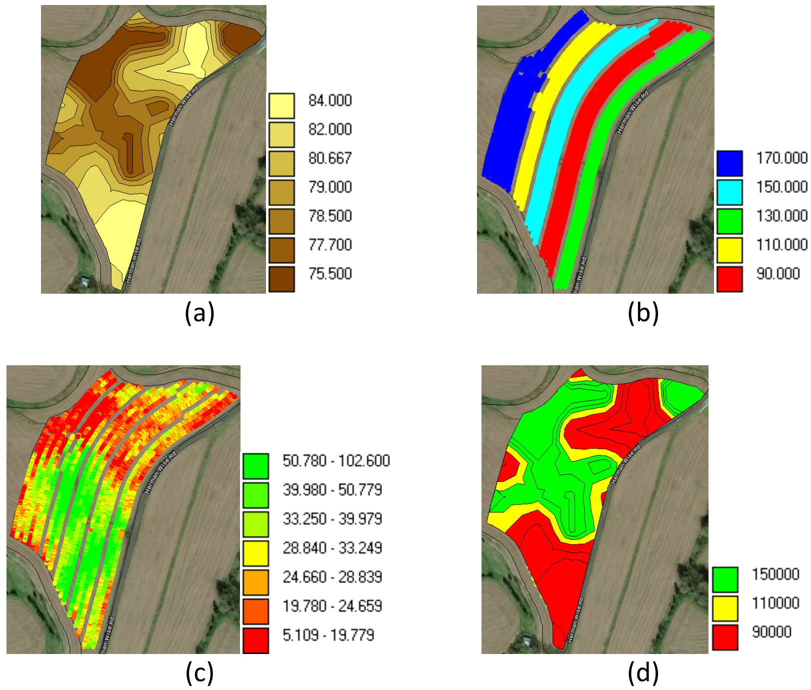


Figure 6. Sand content map (a, %), planting map (b, kseed/ac), yield map (c, bu/ac), and directed prescription (d, seeds/ac) for the 2018 Allendale County site.

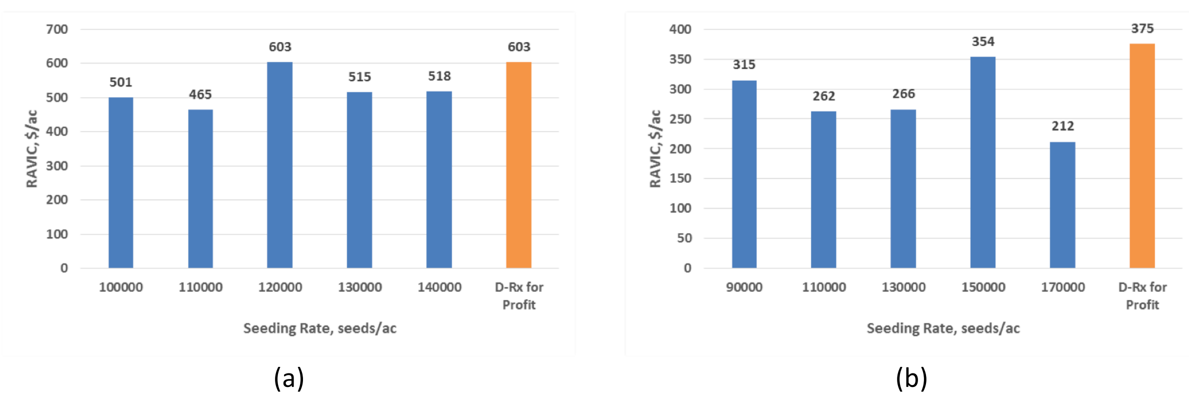


Figure 7. Returns above variable input costs as a function of seeding rate for the Allendale County (a) and Newberry County (b) test sites.