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Characterizing the Decision Process in Setting Corn and Soybean Seeding Rates

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Abstract. Selecting optimal corn and soybean seeding rates are difficult decisions to make. A survey of Ohio and Michigan farm operators finds that, although generally keen to learn from others, they tend to emphasize their own experience over outside information sources. Soybean growers declare university and extension recommendations as more important than do corn growers. In response to direct queries and in free comments, growers place more emphasis on understanding the agronomic and technological problems at hand than on adjusting to the market environment. Given the decision environment, we argue that these responses are reasonable.

INTRODUCTION

For corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.], seed input costs comprise approximately one-fifth of non-land production costs on commercial farms within the U.S. Corn Belt (Schnitkey & Swanson, 2019). In this region, seed is generally the second largest non-land cost for corn and the largest non-land cost for soybeans. Seeding rate decisions are particularly complex for multiple reasons. One such reason is that production factors such as soil types, planting conditions, planting date (De Bruin & Pedersen, 2008; Knott et al., 2019), row spacing (Cox & Cherney, 2011), seed treatment (Gaspar et al., 2017), and cropping history may influence seeding rate decisions. Recent multi-state analysis has demonstrated that optimal seeding rate can vary both between and within regions (Gaspar et al., 2020).

Furthermore, technologies change continuously. The commercial life of a single hybrid of corn is typically about 4.6 years, (Perry et al., 2018) while that of a variety of soybean is about 3.5 years (Conley et al., 2010; Zhang & Bellaloui, 2012). However, seed coating and equipment innovations have increased emergence and seedling survival over the past few decades. Among the most significant innovations in recent times have been precision technologies that allow many growers to have abundant agronomic data available when seeding (Erikson et al., 2017).

Here, we report the opinions provided by growers in Michigan and Ohio regarding how they acquire information to inform seeding rate choices. We also explain why growers should be more interested in learning about the agronomy of seeding rate choices than the economics.

METHODS

During meetings with corn and soybean growers and consultants in 2018, interviewers asked participants about seeding rate decisions relative to available precision agriculture technologies. Prior to organizing the sessions, all survey instruments and research activities were approved by the Internal Review Board at The Ohio State University. Meetings were held in East Lansing, Michigan on the 13 August; Wauseon, Ohio on 20 August; and Columbus, Ohio on 21 August. The coauthors of this article recruited participants via electronic flyer among their grower networks. The intents were to learn about extension needs, to better understand grower decision-making processes, and to facilitate discussions about seeding rate choices through Extension programming. Participants were paid $80 funded from a USDA grant. Meetings were held on university premises, and each lasted about 3.5 hours. Approximately 90 minutes were devoted to administering the paper-format instrument from which the coauthors took the data reported here. Other data were also collected regarding respondents' choice of equipment and their views of the various factors affecting seeding choices. Subjects were facilitated in working through the instrument by an Extension educator. The same facilitator was used at each meeting for consistency. Respondents could chat with table neighbors when responding but group-wide discus-

Table 1. Subject Attendance by Occupation and Location

	East Lansing, MI	Average for growers in area[a]	Wauseon, OH	Average for growers in area[a]	Columbus, OH	Average for growers in area[a]
Grower	12	17,562	15	14,764	10	18,330
Consultant, but not operator	2		6		4	
Total	**14**		**21**		**14**	
			Among growers			
Mean years as grower[b]	19.2	25.1	22.6	26.1	25.6	23.5
Mean age	45.6	56.6	45.1	56.8	44.9	56.6
Share who farm as principal occupation	0.75	0.41	0.60	0.38	0.50	0.39

[a] Area comparisons are from the 2017 Agricultural Census. For East Lansing, the area is Crop Reporting District 80 in Michigan; for Wauseon, District 10 in Ohio; for Columbus, District 50 in Ohio.

[b] In "mean years as cropping operator", we record 15 years for one operator in East Lansing who reported "15+" years, and 12.5 years for another in Wauseon who reported "10–15" years.

sions were not allowed during the survey. Table 1 reports participant characteristics.

The average number of operated acres in our sample were 1,089, 1,768, and 3,248 acres in each of the three locations—Wauseon, Columbus, and East Lansing—respectively. These numbers were much higher than the overall average number of operated acres in the two states, which were below 200 acres (USDA-NASS, 2019). However, our sample farms are representative in terms of proportion of land covered. In 2017, farms of 1,000 acres or more accounted for 8% of U.S farms but controlled nearly 71% of U.S. farmland (USDA-NASS, 2019).

RESULTS AND DISCUSSION

Growers were asked the following question with regard to both corn and soybeans: "How much impact did the following market or human (i.e., non-agronomic) influences have on your overall seeding rate choices in 2018? In each row, please circle the number that best reflects your views. Please also circle the factor that you view as being most important." Eight alternatives were provided, and participants answered on a five-point Likert-type scale from '1 = *Not a Factor*' to '5 = *Very Important Factor*.' Responses are provided in Table 2.

For both crops 'My experience' registered as most important when rated numerically as well as when singled out as the most important factor. There was also consistency when assessing the importance of output and seed prices; neither rank high on average or among a large subset of growers. Views on the importance of peer grower experiences were mixed. For both crops, peer experiences ranked moderately high on average, but no respondent identified them as the most important factor. Some growers, especially of corn, considered dealer recommendations to be important, while others emphasized agronomy consultant recommendations. University and Extension recommendations were viewed as more important to growers for soybeans than for corn.

Growers were also asked, "For the crop management decisions that you made in the last 10 years, or since you have commenced crop farming, please describe up to three thoughts that have influenced your SOYBEAN seeding rate decisions." Responses were categorized into six general areas as presented in Table 3. These are:

1. manageable agronomic factors (disease and weed control, variety selection, seed treatment use, etc.)
2. agronomic factors that in large part cannot be managed or are fixed (soil type or weather)
3. experience from within the operation (internal experience)
4. advice or trial data from individuals outside the production organization (seed dealers, university researchers, agronomists)
5. technology (planter technology, software and mapping capability, etc.)
6. economic factors (input, output prices).

This summary emphasizes the importance that producers place on employing agronomic principles and past experiences when choosing seeding rates. Participants identified the impact of external experiences, fixed agronomic factors, technology, and economic factors, but did not focus on them.

Table 2. Mean Responses for Influences on Crop Seeding Rate Choices

	Soybean		Corn	
	Mean value	**Most important**	**Mean value**	**Most important**
My experience	4.54	22	4.39	14
Peer grower experiences	3.14	0	2.83	0
Dealer recommendation	3.03	1	3.47	6
University/extension recommendations	3.03	3	2.65	1
Agronomy consultant recommendation	2.95	4	2.78	3
Price of crop seed variety I prefer	2.49	0	2.53	1
Expected price of crop	2.46	0	2.39	2
Other market or human influences	1.97	0	1.71	1
Missing	0	7	0	9

Table 3. Categorized Responses from Producers Related to What Factors have Influenced Soybean Seeding Rate Decisions Over the Last Ten Years and Future Information Desired from University Extension

Category	**Number of Responses**	
	Factors that influenced seeding rate decisions, last ten years	Future information desired from university extension
Manageable Agronomic Factors	44	13
Fixed Agronomic Factors	12	10
Internal Experience	28	0
External Experience	13	2
Technology	11	8
Economic Factors	14	8

Responses align well with Table 2 responses, where producers may have considered their agronomic knowledge as a component of their experience. These trends are similar to results from a Nebraska study that showed producers were conservative in adapting their management practices after the introduction of transgenic crops for more efficient production (Peterson et al., 2002) and suggest that producers rely heavily on past experience for current production decisions.

Producers were also asked, "Please describe one or two aspects about variable rate seeding you would like to have more information about from university extension." Both manageable and fixed agronomic factors were identified as of high interest (Table 3). Many comments about fixed agronomic factors were associated with improving seeding rate recommendations for specific soil types. Technology was identified as examining different software or analysis techniques, which may reflect a desire to improve producer capacities for internal evaluation. Participants also requested modules relating to economic principles. Both responses associated with external experience suggested more university studies on planted (15-in spacing) as opposed to drill seeded (7.5-in spacing) soybean rows.

Why do we place less emphasis on learning about the economic environment than about the agronomic environment when making seeding rate choices? One perspective is that there may not be much to learn at planting time. Often by this point, prices for seed have been available for many months, and harvest time prices can be locked in through forward contracts with local grain merchandizers. Another perspective, one that more readily applies for corn than for soybeans, is that there may be little one can do with further price information in any case. Corn is a rigid crop, so cutting back on seed in response to higher seed prices or lower corn prices will just leave unused space and wasted sunlight in the field. A third perspective is that learning whether there are additional resources available for plants to use at a location in a field provides the farmer with a concrete actionable plan—namely, to adjust seeding rate accordingly so that each seed has the level of resources it needs. How one adjusts to new pricing information may be less clear-cut.

CONCLUSIONS

Individual or personal experiences and knowledge of agronomic principles were identified as major drivers in seeding rate decisions. While some participants identified economic factors that affect their decision making, these were not major drivers in seeding determination and considered a mid- to low-level priority in participants' efforts to gain more information.

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