

Predicting Adopters and Non-Adopters of Precision Agriculture Technologies

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Introduction

While the adoption literature about precision agriculture technologies continues to be prevalent, sufficient literature is not available to explain recent adoption trends of precision agriculture among row-crop producers in the southern US. Hudson and Hite (2001) surveyed row-crop producers about their use and perceptions of precision agricultural technologies and found that row-crop framers had primarily adopted soil sampling and precision agricultural analysis techniques. However, Hudson and Hite (2001) also found that other precision agriculture technologies, such as GPS guidance and variable rate applications, continued to be adopted at a low rate.

Poindexter (2018) conducted a similar adoption study where he found that farm size and age had a considerable influence on the adoption of auto-steer among row-crop producers in Mississippi. Other adoption studies have included states in the Southeast in their analysis (Edge et al. 2018; Erickson et al., 2017), but their focal populations were not exclusively farmers in those states. To date, little empirical evidence exists that describe the different precision agricultural practices being used, how those practices are being used, and why those practices are being used among row-crop producers in southern US states.

The purpose of this study was to investigate what precision agricultural practices selected row-crop (soybean, wheat, corn, cotton, peanuts, and rice) producers have adopted in selected southern US states. The following were specific research objectives for the study: (1) Predict the likelihood of farmers classified as adopters or non-adopters of precision agriculture by the variables of farm size and age and row crop producers, and (2) Predict the number of precision agricultural technologies adopted by row-crop producers based on the variables of farm size, age, and perceived innovations attributes (relative advantage, compatibility, complexity, observability, and trialability).

Theoretical Framework

Rogers' (2003) Diffusion of Innovations Theory provided the theoretical framework for this study. Diffusion can be defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 35). In comparison, adoption is considered a decision made by an individual or organization to accept, modify, reject, or discontinue a given innovation (Kee, 2017). Rogers (2003) posited that "innovation", "communication channel", "time" and a "social system" are the four fundamental elements of the diffusion of innovations theory (p. 11). Rogers (2003) indicated that based on the characteristics of individuals described above, they can be classified into adopter categories, which he termed "innovators", "early adopters", "early majority", "late majority", and "laggards" (p. 284).

Methodology

For this correlational research study, a convenience sample of row-crop farmers who attended the Mississippi State University Extension 2021 Row Crop Short Course, the Tri-State Soybean Forum, the National Black Growers Council Annual Meeting, and Auburn University Extension 2022 Row Crops Short Course filled out the questionnaire along with farmers on the [experiment station] and US FARM DATA mailing list were emailed a link ($n = 151$) with 126 usable responses. The instrument was devised using the CropLife/Purdue precision agriculture services dealership questionnaire (Lowenberg-DeBoer & Erickson, 2019) and Moore and Benbasat's (1991) questionnaire designed to measure the perceptions of adopting information technology innovations. Since 1997, the CropLife/Purdue survey has been collecting information concerning the

development and adoption of precision agricultural trends (Lowenberg-DeBoer & Erickson, 2019). Additional questions were developed by the research to measure perceived innovation attributes of precision agriculture. The independent variables of farm size and age were entered into a logistic regression model to determine the likelihood of farmers being adopters or non-adopters of precision agriculture practices. Multiple linear regression was also used to predict the number of precision agricultural technologies adopted by row-crop producers based on the variables of farm size, age, and perceived innovations attributes (relative advantage, compatibility, complexity, observability, and trialability).

Results

A logistic regression analysis was conducted to determine whether precision agriculture practices could be predicted by the age of row-crop producers and the amount of total acreage they farmed. A Nagelkerke $R^2 = .163$ for the full model suggested that 16.3% of the variance experienced in the dependent variable could be explained by the independent variables of producers' age and amount of acreage farmed. Results indicated that the predictors, as a pair, can reliably distinguish between adopters of precision agriculture practices compared to non-adopters of precision agriculture practices. Considering the two predictors in the model, only the amount of acreage was a statistically significant predictor for whether a producer adopted or did not adopt precision agriculture as a practice (Wald = 7.07, $df = 1$, $p = .008$). The age of row crop producers as a predictor was not statistically significant, which implied that the odds of adopting or not adopting autosteer remained the same regardless of producers' age. Results from the multiple regression analysis suggested the number of acres respondents farmed, age of the producers, and precision agriculture perceived attributes did not significantly contribute to the total variation as it concerned the amount of precision agricultural technologies adopted, $F(6,93) = 1.194$, $p = .317$. However, the amount of acreage farmed by row-crop producers was a significant predictor of the total amount of precision agricultural technologies adopted ($t = -2.28$, $df = 93$ $p = .019$).

Conclusions

The age of producers and how they perceived precision agriculture was not a significant determinant of whether or not they had adopted precision agriculture. In contrast, the amount of acreage a producer farmed was a significant determinant of whether they had adopted precision agriculture. Furthermore, the number of acres respondents farmed, age of the producers, and precision agriculture perceived attributes did not significantly contribute to the total amount of precision agricultural technologies adopted. However, the amount of acreage farmed by row-crop producers in this survey was a significant predictor of the total amount of precision agricultural technologies adopted.

Implications/Recommendations

Precision agriculture has the potential to improve the efficiency of agriculture (Shannon et al., 2018). While the majority of row-crops producers surveyed had adopted some form of precision agriculture, there is not a full adoption of the precision agriculture practices and technologies. Future research may be beneficial to understand why some farmers were willing to adopt the different precision agriculture practices and technologies and why some did not. Researchers should consider investigating what factors influenced the adoption of precision agriculture other than age, farm size, and perception toward precision agriculture. Future investigations should focus on how the type of crop harvested, PA information source, PA services providers, region, and willingness to pay for PA influence row crop producers' decision to adopt precision agriculture.

References

- Edge, B., Velandia, M., Boyer, C., Larson, J., Lambert, D., Roberts, R., & Falconer, L. (2018). Automatic section control technologies and GPS auto-guidance systems adoption in cotton production. *Journal of Agricultural Science*, *10*(7), 282–294.
- Erickson, B., Lowenberg-DeBoer, J., & Bradford, J. (2017). *2017 Precision agriculture dealership survey*. Department of Agricultural Economics, Purdue University. <https://agribusiness.purdue.edu/wp-content/uploads/2019/07/croplife-purdue-2017-precision-dealer-survey-report.pdf>
- Hudson, D., & Hite, D. (2001). *Adoption of precision agriculture technology in Mississippi: preliminary results from a producer survey*. Mississippi State University. <https://ageconsearch.umn.edu/record/15787/>
- Kee, K. F. (2017). *Adoption and diffusion*. The international encyclopedia of organizational communication. John Wiley & Sons, Inc. <https://www.chapman.edu/research/institutes-and-centers/leatherby-center/files/research-office-photos/Adoption-and-Diffusion.pdf>
- Lowenberg-DeBoer, J., & Erickson, B. (2019). Setting the record straight on precision agriculture adoption. *Agronomy Journal*, *111*(4), 1552. <https://doi.org/10.2134/agronj2018.12.0779>
- Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, *2*(3), 192–222. <https://doi.org/10.1287/isre.2.3.192>
- Poindexter, P.J. (2018). *Investigating the adoption of auto-steer by row-crop farmers in [state]* (Publication No. 10841453). [Doctoral dissertation, [state] University]. Proquest Dissertations and Theses Global.
- Rogers, E.M. (2003). *Diffusion of innovations*. Free Press.
- Shannon, D. K., Clay, D.E., & Sudduth, K.A. (2018) An Introduction to precision agriculture. In (Shannon, D.K., Clay, D.E., & Kitchen, N.R) *Precision agriculture basics*, (1-12). American Society of Agronomy, Inc; Crop Science of America; Soil Science Society of America.