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FACTORS AFFECTING ADOPTION OF COTTON PRECISION FARMING TECHNOLOGIES IN THE SOUTHEAST

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Abstract

Probit analysis of responses from a 2001 survey of cotton farmers in six southeastern states was used to determine the factors that influenced cotton farmers to adopt site-specific information gathering technologies and variable rate input application technologies. Farm size, land quality, college attendance, the farmer's age, and the farmer's perceptions about the future profitability and importance of cotton precision farming were significant factors affecting the adoption of site-specific information gathering technologies. Adoption of variable rate input application technologies was influenced by farm size, land tenure, the farmer's age, the farmer's knowledge about the costs and potential benefits of precision farming, and the farmer's perceptions about the future profitability and importance of cotton precision farming.

Introduction

Cotton is a high-value, high-input crop with potential for profitable precision farming and reductions in input losses to the environment (Roberts et al., 2002b). The objective of this research was to determine the factors that influence cotton farmers to adopt site-specific information gathering technologies (e.g., yield monitoring, grid or management zone soil sampling, satellite imagery, soil survey maps) and variable rate input application technologies (e.g., fertilizer, lime, herbicide, growth regulator). Identifying these factors could help policymakers increase input efficiency through policies that stimulate the adoption of precision farming technologies. Extension programs and agribusiness firms might also benefit from targeting their efforts toward farmers who are most likely to adopt and purchase these technologies.

Materials and Methods

The farmer who maximizes expected utility has three mutually exclusive choices: 1) use site-specific information gathering technology (IGT) and variable rate input application technology (VRT); 2) use IGT and uniform rate input application technology (URT), or 3) use traditional whole-field information gathering technology and URT. Gathering whole-field information and using VRT is not possible because the site-specific information necessary for VRT use was not gathered. By choosing to gather site-specific information, the farmer is self-selected into the group of farmers who can choose between VRT and URT. This property implies the use of probit regression methods that account for sample selection (Greene, 1997; Khanna, 2001).

Data were collected from a mail survey of cotton producers in Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee conducted in 2001 (Roberts et al., 2002a). Farmers were asked whether they had used the following site-specific information gathering technologies: yield monitoring with GPS, yield monitoring without GPS, grid soil sampling, management zone soil sampling, aerial photography, satellite imagery, soil survey maps, mapping soil and field characteristics, plant tissue testing, and on-the-go sensing. Use of IGT was attributed to farmers who indicated that they had used at least one of

these site-specific information gathering technologies. Farmers were also asked if they had used the following variable rate input application technologies: variable rate phosphorous and potassium, nitrogen, lime, seed, growth regulator, defoliant, fungicide, herbicide, insecticide, and irrigation. Use of VRT was ascribed to farmers who indicated that they had used at least one of these variable rate input application technologies. Of the 5,976 cotton producers surveyed, 1,131 (19%) responded. The number of usable responses was reduced to 773 because of missing data. Of these 773 respondents, 153 (20%) said they used IGT and 89 of the 153 respondents who used IGT (58%) said they used VRT.

A bivariate probit model was specified with two dependent variables: 1) $I_s = 1$ if the farmer used IGT and $I_s = 0$ otherwise, and 2) $I_v = 1$ if the farmer used both IGT and VRT and $I_v = 0$ otherwise. The model was first estimated with the correlation (ρ) across the two equations unconstrained and then again with ρ constrained to zero. A likelihood ratio test was performed to test the null hypothesis that ρ equals zero. Individual binomial probit models can be estimated for the two equations if the null hypothesis is not rejected (Greene, 1997, 1998).

Results

The estimate of ρ was 0.39 with a standard error of 12.72 and a t-ratio of 0.031. The likelihood ratio test also indicated failure to reject the null hypothesis that ρ equals zero. The likelihood ratio test statistic was $-2(-441.00 - (-440.96)) = 0.08$ (Chi-squared, 1 df). Therefore, individual binomial probit models were estimated. Highly significant Chi-squared statistics indicated that the binomial probit models significantly explained the use of IGT and VRT. The VRT model correctly predicted 71 of 89 farmers (80%) who used both IGT and VRT and it correctly predicted 36 of 64 farmers (56%) who used IGT but not VRT. The probit model for IGT correctly predicted 616 of 620 farmers (99%) who used neither of these precision farming technologies.

Farm size, land quality, college attendance, the farmer's age, and the farmer's perceptions about the future profitability and importance of precision farming significantly influenced the probability that a farmer would use IGT. Use of VRT was significantly explained by farm size, land tenure (owned minus rented land), the farmer's age, the farmer's knowledge about the costs and potential benefits of precision farming, and the farmer's perceptions about the future profitability and importance of cotton precision farming. Using a computer for farm management was not a significant factor in explaining the use of IGT or VRT perhaps because cotton farmers typically custom hire these technologies, shifting much of the burden of computer use to agribusiness firms.

Conclusions

Results can be used by policymakers, extension personnel, and agribusiness firms to develop policies, extension programs, and promotional efforts targeted toward farmers who are most likely to benefit from, adopt, and purchase site-specific information gathering and variable rate input application technologies. For example, targeting IGT policies, extension programs, and agribusiness promotional efforts toward younger, more educated cotton farmers who operate larger farms of higher land quality and who are optimistic about the future of precision farming would likely be more fruitful than targeting other farmers. Results also suggest that greater success would likely be achieved by targeting VRT efforts toward younger farmers who operate larger farms, own more of the land they farm, are well informed about the costs and potential benefits of precision farming, and are optimistic about the future of precision farming.

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