FACTORS INFLUENCING THE TIMING OF PRECISION FARMING TECHNOLOGY ADOPTION

Pattarawan Watcharaanantapong
R. K. Roberts
D. M. Lambert
J. A. Larson
M. Velandia
B. C. English
The University of Tennessee
Knoxville, TN
R. M. Rejesus
M. C. Marra
North Carolina State University
Raleigh, NC
A. K. Mishra
Louisiana State University
Baton Rouge, LA
Chenggang Wang
Texas Tech University
Lubbock, TX

Introduction

Precision farming (PF) technology is defined as a single technology or a suite of technologies used to manage variability of soils, yields, pests, fertilizers and other factors affecting crop production within a field by collecting spatial data throughout the field. This information is then used to make decisions about applying inputs to reduce cost (e.g., fertilizer and seed costs), increase yield and profit, and improve environmental quality. The objective of this research was to identify factors influencing Southern cotton farmers' decisions to adopt yield monitoring (YMR), passive remote sensing (RMS) and grid soil sampling (GSS) at different points in time. The results will be useful for researchers and agricultural support personnel in helping farmers make decisions to improve input efficiency, increase profit and decrease negative environmental impacts. Additionally, the results can provide information to farmers for making technology adoption decisions now and in the future, and can help research scientists put PF technology adoption and diffusion into a historical perspective for future research.

Methods

Data for cotton farmers in 12 states were obtained from the Cotton Incorporated Southern Cotton Precision Farming Survey conducted in 2009 for the 2008 crop. Tobit models were used to evaluate the factors influencing Southern cotton farmers' decisions to adopt the three site-specific information technologies. The numbers of years a farmer had used each of the PF technologies were used as dependent variables. Independent variables hypothesized to influence the number of years used include farm characteristics, such as the size of farm; farmer characteristics, such as age and education; farmer perceptions, such as beliefs that PF technologies would be profitable for him/her to use in the future; information sources, such as farm dealers and crop consultants; adoption of other PF technologies; and regional characteristics.

The relationship between the year t when farmer i adopted PF technology j and the number of years they used the technology is:

$$yearsused_{ij} = 2009 - t_{ij},$$

where $yearsused_{ij}$ is the number of years farmer i had used PF technology j as of 2009 when the survey was conducted, and t is the year the farmer adopted PF technology j. The $yearsused_{ij}$ was the dependent variable for three Tobit models (j = YMS, RMS and GSS) (Maddala 1983) :

$$yearsused_{ij} = \beta x_{ij} + e_{ij}$$

if $yearsused_{ij} > 0$, else $yearsused_{ij} = 0$,

where β is a vector of unknown parameters, x_{ij} represent the factors affecting $yearsused$ and e_{ij} is an error vector. If $yearsused_{ij} > 0$ (uncensored observation), the farmer adopted PF technology j in year t; if $yearsused_{ij} = 0$ (censored observation), the farmer did not adopt PF technology j.

Results

Results suggest that cotton farmers who had higher yields, had taxable household income of $100,000 or greater, used a computer for farm management and a laptop in the field, adopted GSS before YMS, and thought PF would be profitable in the future and improve environmental quality adopted YMS earlier than other farmers. Farmers in Texas adopted YMS later than farmers in Alabama, Florida, Arkansas, Louisiana, Mississippi, North Carolina, Tennessee and Virginia.

Cotton farmers who operated larger farms, obtained PF adoption information from the news/media and thought PF would be profitable and important in the future adopted RMS earlier than others. Farmers in Arkansas, Louisiana, Missouri, Mississippi and South Carolina adopted RMS earlier than Texas farmers.

More educated cotton farmers with larger portions of owned than rented land who obtained PF adoption information from crop consultants, used a computer for farm management and thought the use of PF would improve cotton and environmental quality adopted GSS earlier than others. Farmers who adopted YMS before GSS and obtained PF adoption information from the news media adopted GSS later than other farmers. Farmers in Texas adopted GSS later than farmers in all other states, except Virginia (Table1).

Summary

Different factors influence cotton farmers' timing of YMS, RMS and GSS adoption in the technology diffusion process. Results can be used to develop education programs targeting technology-specific information to meet the needs of specific groups of farmers. Agribusiness firms can use the results to aim promotional efforts toward farmers who are likely to benefits the most from early adoption of similar new technologies.

References

Maddala, G. S. 1988. *Introduction to Econometrics*. New York, USA: Macmillan Publishing Company.

Roger, E. M. 1983. *Diffusion of Innovations* (3rd ed.). New York: Free Press.

Roger, E. M. 1995. *Diffusion of Innovations* (4th ed.). New York: Free Press.

Table 1. Summary of significant variables for yield monitoring, passive remote sensing and grid soil sampling.

Significant Variables	Definition
Farmsize[3]	Acres of cotton farmed in 2007 or 2008 (largest size)
Yield[1]	Lint yield (lbs/acre) in 2007 or 2008 (largest yield)
Ratio_rentown[3]	Ratio of rented to total land farmed in 2007 or 2008 (largest size)
Profitable[1,2]	Farmer thought PF would be profitable for him/her to use in the future (yes=1; else =0)
Important[2]	Farmer thought PF technologies would be important in his/her state five years in the future (yes=1; else=0)
Cotton_quality[3]	Farmer thought PF would improve lint quality (yes=1; else=0)
Envi_quality[1,3]	Farmer thought PF would improve environmental quality (yes=1; else=0)
Consultants[2,3]	Farmer used crop consultants to obtain PF information (yes=1; else=0)
News/Media[2,3]	Farmer used news/media to obtain PF information (yes=1; else=0)
Computer[1,2,3]	Farmer used computer for farm management (yes=1; else=0)
Laptop[1]	Farmer used laptop or handheld in the field (yes=1; else=0)
med_income[1]	Taxable household income from both farm and non-farm sources between $100,000 and $199,999 in 2007 (yes=1; else = 0)
high_income[1]	Taxable household income from both farm and non-farm sources of $200,000 or greater in 2007 (yes=1; else=0)
AL_FL[1,3]	Farm located in Alabama or Florida (yes=1; else=0)
AR[1,3]	Farm located in Arkansas (yes=1; else=0)
GA[3]	Farm located in Georgia (yes=1; else=0)
LA[1,2,3]	Farm located in Louisiana (yes=1; else=0)
MO[2,3]	Farm located in Missouri (yes=1; else=0)
MS[1,2,3]	Farm located in Mississippi (yes=1; else=0)
NC[1,3]	Farm located in North Carolina (yes=1; else=0)
SC[2,3]	Farm located in South Carolina (yes=1; else=0)
TN[1,3]	Farm located in Tennessee (yes=1; else=0)
VA[1]	Farm located in Virginia (yes=1; else=0)

1 = significant at 10% levels in YMS Tobit model.

2 = significant at 10% levels in RMS Tobit model.

3 = significant at 10% levels in GSS Tobit model.

Taxable household income less than $100,000 is the reference category.

Texas is the reference location.