COTTON PRECISION FARMING ADOPTION IN THE SOUTHERN UNITED STATES: FINDINGS FROM A 2009 SURVEY

Daniel F. Mooney, Roland K. Roberts, Burton C. English, James A. Larson, Dayton M. Lambert, and Margarita Velandia

Department of Agricultural and Resource Economics
University of Tennessee
Knoxville, Tennessee

Sherry L. Larkin

Department of Food and Resource Economics
University of Florida
Gainesville, Florida

Kenneth W. Paxton and Ashok Mishra

Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, Louisiana

Steve W. Martin

Delta Research and Extension Center
Mississippi State University
Stoneville, MS

Michelle C. Marra and Roderick Rejesus

Department of Agricultural and Resource Economics
North Carolina State University
Raleigh, North Carolina

Eduardo Segarra and Chenggang Wang

Department of Agricultural and Resource Economics
Texas Tech University
Lubbock, Texas

Jeanne M. Reeves

Cotton Incorporated
Cary, North Carolina

ABSTRACT

The objectives of this study were to determine the status of cotton precision farming in 12 southern U.S. states, explore producer perceptions about cotton precision farming technologies, and compare farm and demographic characteristics for adopters and non-adopters. A mail survey of cotton producers in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas and Virginia was conducted in 2009 to establish the use of precision farming technologies in 2007 and 2008 in these states. A total of 1,981 cotton producers responded for a response rate of 12.5%. Fifty-seven percent of respondents were classified as cotton precision farming adopters, having used one or more cotton precision farming technology. The most common information gathering technologies used were grid and zone soil sampling, cotton yield monitors with GPS, and soil survey maps. The most common variable rate decisions included fertilizers and growth regulators. On average, adopters farmed more total and cotton crop acres, rented a larger share of their farm acreage, and had higher yields than did non-adopters. Similarly, adopters were on average younger, more educated, obtained a higher share of their income from farming, and had higher levels of computer usage.

Keywords: Precision agriculture, cotton, producer survey, site-specific management, technology adoption

INTRODUCTION

Precision farming technologies are used to identify and measure within-field variability and its causes, prescribe site-specific input applications that match varying crop and soil needs, and apply the inputs as prescribed. When used as a package, these technologies may increase production efficiency, reduce input use, and increase yields and profits. While commercial cotton yield monitors became available only recently, other cotton precision farming technologies have been available for some time. Previously, Roberts et al. (2002) and Cochran et al. (2006) assessed trends in cotton precision farming, factors influencing technology adoption decisions, and the likelihood that producers will continue using these technologies in the future. Despite recent market volatility, cotton remains an important high-value crop for southern U.S. producers, grown on over 7 million acres and representing 92% of U.S. cotton acres harvested in 2009 (USDA, 2010). In order to further appraise the present status and future prospects of cotton precision farming, a need exists to reevaluate producers' experiences since 2005.

The objectives of this study were to 1) determine the status of cotton precision farming in 12 southern U.S. states, 2) explore producer perceptions about cotton precision farming technologies, and 3) compare farm and demographic characteristics for adopters and non-adopters. The *2009 Southern Cotton Precision Farming Survey*, for which results are summarized in this paper, is the third in a series of cotton precision farming surveys. In each year the survey has

been conducted, the geographical region considered has expanded. Originally, in 2001, six states were surveyed—Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee. In 2005, the area increased to eleven states, adding Arkansas, Louisiana, Missouri, South Carolina, and Virginia. The 2009 survey described here includes these same eleven states plus Texas.

In the 2001 Southern Cotton Precision Farming Survey, Roberts et al. (2002) classified 23% of survey respondents as cotton precision farming adopters. Adopters were defined as those respondents who used an information gathering technology or made a variable rate management decision. Among the most widely used technologies were grid and zone soil sampling; variable rate lime, phosphorous, and potassium; and soil survey maps. Only 2% of producers reported yield monitoring with GPS. In the 2005 follow-up survey, Cochran et al. (2006) reported 48% of survey respondents to be cotton precision farming adopters. Grid and zone soil sampling and the variable rate application of lime, phosphorous, and potassium remained as the most common technologies used; however the use of a cotton yield monitoring system equipped with GPS grew considerably with 6% of respondents having reported using this technology.

This paper presents findings from the 2009 Southern Cotton Precision Farming Survey. While this paper describes findings only for 2009, similar summaries from the 2001 and 2005 surveys are available (Roberts et al., 2002; Cochran et al., 2006). In addition, Mooney et al. (2010a) compared the survey data across years and summarized major trends since 2000. Future research by The Cotton Incorporated Economics of Precision Farming Working Group will continue to using this survey data to further appraise the present status and future prospects of cotton precision farming by southern U.S. cotton farmers.

DATA AND METHODS

Cotton Precision Farming Survey

A mail survey of cotton producers in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia was conducted in 2009, to establish the current use of cotton precision farming technologies in these states. The survey questionnaire was developed to elicit cotton farmer attitudes toward and use of precision farming. A mailing list of potential cotton producers was furnished by the Cotton Board in Memphis, Tennessee. Following Dillman's (1978) general mail survey procedures, the questionnaire, a postage-paid return envelope, and a cover letter explaining the purpose of the survey were sent to each producer. A reminder post card was sent two weeks after the initial mailing. A second mailing of the questionnaire to producers not responding to previous inquiries was then conducted three weeks later. The second mailing included a letter indicating the importance of the survey, the questionnaire, and a postage-paid return envelope.

Survey Response

The population of interest was the set of all active cotton producers residing within the twelve-state survey region. A mailing list of 14,089 potential cotton

producers for the 2007-2008 marketing year was furnished by the Cotton Board in Memphis, Tennessee. Survey questionnaires were mailed to all addresses, of which 306 were undeliverable and subsequently dropped. Among responses received, 1,692 were counted as valid, 85 declined participation, and 204 had either retired or did not plant cotton. Assuming those who declined participation and all remaining non-respondents are active cotton producers, the total number of cotton farmers surveyed was 13,579. The survey response rate of 12.5% was then calculated as the number of valid responses divided by the number of cotton farmers surveyed (Figure 1). For the purpose of survey weighting, this analysis used only the 1,521 respondents who reported cotton acres planted.

Comparison with the 2007 Census of Agriculture

The number of producers surveyed and cotton acres planted in 2007 and 2008 were compared with the 2007 U.S. Census of Agriculture (US Department of Agriculture, 2007). While slightly fewer cotton farmers were surveyed than enumerated by the Census, their distributions across states were similar (Table 1). Over 40% of producers were located in Texas, whether according to the Census or the Cotton Board mailing list. This comparison holds for other states as well, with Georgia having the second largest share of respondents at 15%. Alabama, Arkansas, Mississippi, and North Carolina each represented 5% to 10% of total cotton farmers surveyed, whereas Florida, Louisiana, Missouri, South Carolina, Tennessee, and Virginia each represented less than 5% of those surveyed. Figure 2 compares the distribution of respondents' cotton acres planted in 2007 and 2008 with the distribution of cotton acres harvested as reported in the 2007 Census. Fewer cotton producers who grew 249 cotton acres or less responded to the survey as compared with the share reported in the 2007 Census.

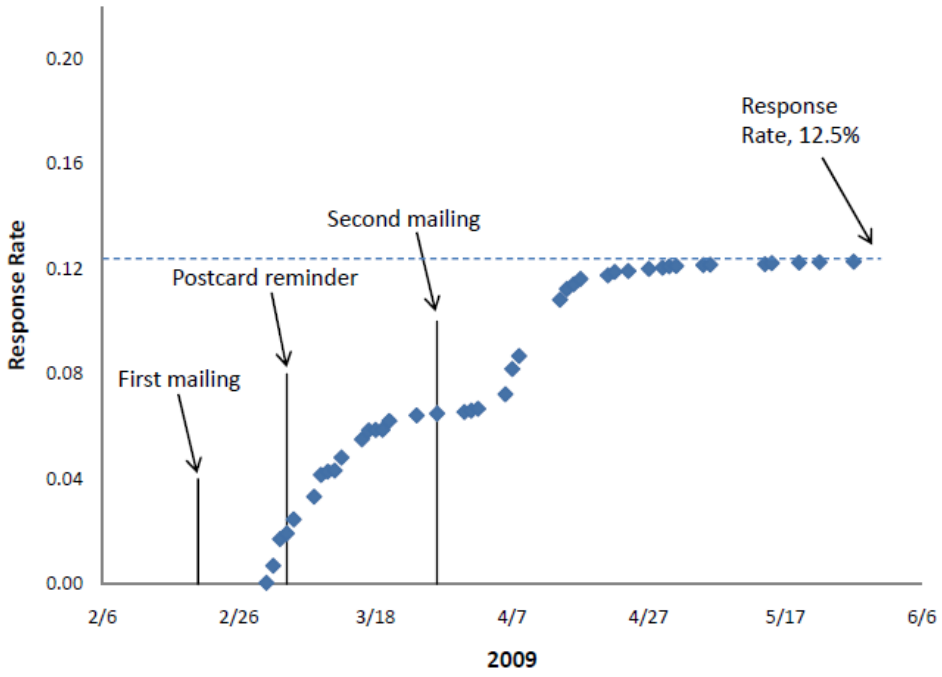

Fig. 1. Survey response rate – 2009 Southern cotton precision farming survey

Table 1. Number of cotton farmers surveyed and useable response rates by state – 2009 Southern cotton precision farming survey

State	2007 Census of Agriculture[1]		Cotton farmers surveyed[2]		Useable surveys returned[3]	
	N	% of total	N	% of total	N	% response
Alabama	917	5.5	782	5.8	106	13.6
Arkansas	915	5.5	812	6.0	63	7.8
Florida	213	1.3	184	1.4	27	14.7
Georgia	2,577	15.4	2,046	15.1	169	8.3
Louisiana	645	3.9	581	4.3	71	12.2
Mississippi	980	5.9	714	5.3	128	17.9
Missouri	511	3.1	464	3.4	34	7.3
North Carolina	1,308	7.8	1,036	7.6	169	16.3
South Carolina	458	2.7	355	2.6	48	13.5
Tennessee	779	4.7	631	4.6	105	16.6
Texas	7,225	43.2	5,812	42.8	749	12.9
Virginia	196	1.2	162	1.2	23	14.2
12-state total	16,742	100	13,579	100	1,692	12.5

[1] US Department of Agriculture (2007). [2] Number of addresses on the 2007-2008 Cotton Board mailing list minus invalid addresses and respondents who did not farm cotton. [3] Respondents who produced cotton at least once during 2005-2008.

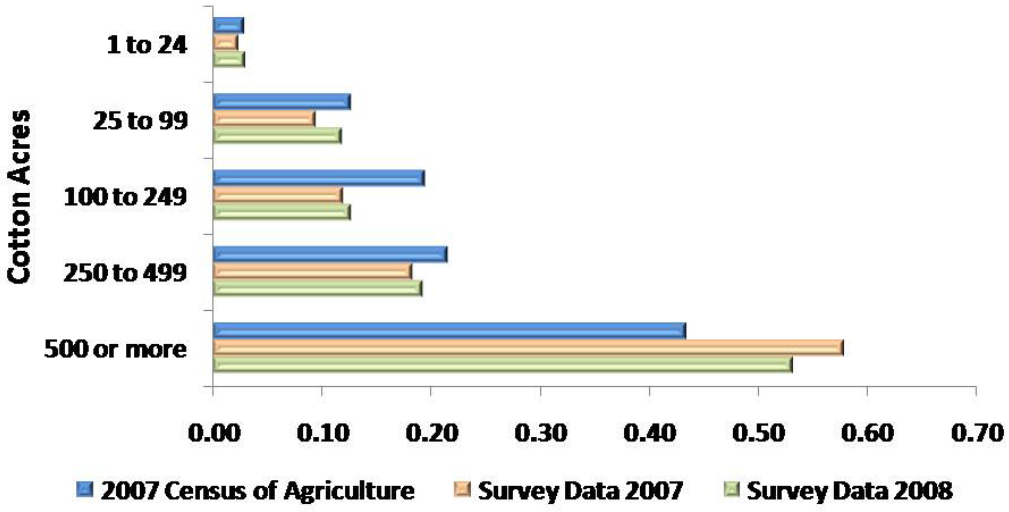

Fig. 2. Distribution of cotton acres planted as compared with the census – 2009 Southern precision farming survey

Survey Weights

Summary statistics representative of the target population were obtained using post-stratified survey weights. Post-stratification adjusts for the over- or under-representation of survey respondents within strata (e.g., among states [Table 1] or farm sizes [Fig. 2]) based on known population counts (Lohr, 1999). Respondents were first assigned to one of 72 strata depending on farm location and cotton acreage (12 states × 6 acreage classes [1–99, 100–249, 250–499, 500–999, 1000–1999, or 2000+ acres]). Weights were then obtained via a raking procedure calibrated to the 2007 Census of Agriculture (Brackstone and Rao, 1976). Finally, the SURVEYMEANS and SURVEYFREQ procedures in SAS 9.1 were used to obtain weighted summary statistics. The results presented here include only those respondents (n=1,521) who provided cotton acres planted in 2007 or 2008. For unweighted survey statistics see Mooney et al. (2010b).

RESULTS AND DISCUSSION

Overall Precision Farming Adoption

Respondents were defined as precision farming adopters if they reported using information gathering technology, variable rate management, or GPS guidance. Overall, 57% of producers surveyed were classified as precision farming adopters (Table 2). Virginia and Tennessee had the highest rates of adoption, whereas Texas had the lowest. Many farmers adopted more than one type of precision farming technology (i.e., some combination of information gathering, variable rate management, and GPS guidance technologies), so adoption rates are also reported individually for each of these classes.

Overall adoption rates for selected technologies are presented in Table 3. Grid and zone soil sampling were among the most widely adopted, followed by yield monitors and aerial/satellite imagery. Electrical conductivity and handheld GPS/PDA units were also adopted but by fewer producers. While soil maps were also among the most widely adopted technologies, all but seven soil map adopters reported using these maps in combination with at least one additional information gathering technology. COTMAN, digitized mapping, and Greenseeker systems were also reported, but by fewer (≤20) producers.

Use of Information Gathering Technologies

Information gathering technology adopters indicated if they used one or more of eleven information gathering technologies, the number of years used, and the number of acres the technology was used for in 2007. On average, adopters used 2.1 different technologies. Grid and zone soil sampling were the most widely used (Table 4). Zone soil sampling was used for an average of 13.8 years on over 950 cotton acres, whereas grid soil sampling was used for 5.7 years on slightly fewer acres. The cotton yield monitor with GPS, soil survey maps, and aerial photography were the next most commonly used technologies. Least used were

yield monitoring without a GPS, satellite imagery, handheld GPS/PDA, COTMAN plant mapping, digitized mapping, and electrical conductivity.

Table 2. Overall adoption of precision farming technologies by state– 2009 Southern cotton precision farming survey

State	Survey response	Precision farming adoption rates by technology category			Overall precision farming adoption[1]
		Information gathering	Variable rate management	GPS guidance	
	N	%	%	%	%
AL	95	38.6	20.0	32.0	55.4
AR	57	52.1	31.1	58.1	69.9
FL	23	27.5	14.2	68.0	72.1
GA	156	38.6	21.1	35.0	52.2
LA	60	62.8	38.4	46.6	68.4
MS	106	52.7	35.3	37.5	61.4
MO	32	57.1	22.9	47.5	73.0
NC	157	44.2	23.4	38.8	61.4
SC	44	60.1	33.4	35.6	67.4
TN	88	57.3	32.3	50.5	75.9
TX	680	21.4	10.2	38.8	50.7
VA	23	52.7	22.0	56.0	78.2
Total	1521	36.1	19.4	40.4	57.3

[1] Includes producers who used information gathering technology, variable rate management, or GPS guidance. Adoption rates by category do not sum to the overall adoption rate because some producers adopted multiple technologies.

Table 3. Adoption rates for selected precision farming technologies -- 2009 Southern cotton precision farming survey

Precision farming technology	Respondents	Adoption rates
	N	%
Yield monitor	1521	8.1
Grid soil sample	1521	14.8
Zone soil sample	1521	12.6
Grid or zone soil sample	1521	26.6
Aerial/satellite imagery	1521	7.9
Soil map	1521	14.7
Handheld GPS/PDA	1521	4.2
COTMAN	1521	1.5
Digitized mapping	1521	0.5
Electical conductivity	1521	3.6

Greenseeker	1521	0.4

Table 4. Use of information gathering technologies by cotton farmers -- 2009 Southern cotton precision farming survey

Information Gathering Technology	Respondents using each technology	Years used		Acres used in 2007	
	%	N	Avg. Years	N	Avg. Acres
Yield monitor – with GPS	22.8	85	3.6	68	1853
Yield monitor – no GPS	7.3	27	3.4	20	1237
Soil sampling – grid	51.8	194	5.7	160	872
Soil sampling – zone	52.3	193	13.8	178	955
Aerial photos	17.8	68	10.1	55	1219
Satellite images	6.5	25	5.0	23	1004
Soil survey maps	23.5	86	15.0	74	964
Handheld GPS/PDA	8.5	34	4.2	26	1184
COTMAN plant mapping	4.3	15	5.4	16	633
Digitized mapping	2.5	9	4.6	6	1193
Electrical Conductivity	10.3	39	2.7	33	691
Number of respondents	400	370		350	
Number of information gathering technologies	2.1	2.1		1.9	

Use of Variable Rate Management

Variable rate management adopters reported the specific variable rate decisions made and the information gathering methods on which they based these decisions (Table 5). Yield monitors with GPS were the most frequently used information gathering technologies for variable rate decisions. Greenseeker units were least used overall, but were used to make more variable rate decisions (on average) than other technologies. Yield monitors, handheld GPS units, and electrical conductivity units were most commonly used for fertility or lime variable rate decisions. By contrast, the Greenseeker and aerial/satellite imagery were used most commonly for growth regulator and harvest aid variable rate decisions.

Table 6 summarizes the direction and magnitude of input use change following variable rate adoption. A greater number of variable rate adopters for fertilizer, lime, and seed inputs reported a decrease in input use than an increase. In contrast, more variable rate growth regulator, harvest aid, fungicide, herbicide, and insecticide adopters reported an increase in the use of these inputs than a decrease. Among those reporting a decrease in input use, the average decrease ranged from -11% (for seed) to -28% (for lime). By comparison, this range was

somewhat narrower among those reporting an increase in input use, ranging from +17% (for harvest aids) to +48% (for seed).

Table 5. Variable rate management decisions and information gathering technology used – 2009 Southern cotton precision farming survey

Variable rate decision	Handheld GPS units	Green-seeker	Yield monitoring with GPS	Aerial/ satellite imagery	Electrical conduc-tivity	Total
	%	%	%	%	%	%
Drainage	14	22	28	26	17	22
Fertility/lime	81	44	65	48	81	67
Seeding	14	22	33	15	15	21
Growth regulator	19	67	22	48	9	27
Harvest aids	19	44	21	34	4	22
Fungicide	11	11	15	11	2	11
Herbicide	21	22	24	10	6	17
Insecticide	21	33	18	15	8	17
Irrigation	11	33	18	25	9	17
Number of respondents	52	6	76	54	45	
Number of variable rate decisions	2.2	4.5	2.9	3.0	1.7	

Table 6. Direction and magnitude of input use change following variable rate adoption – 2009 Southern cotton precision farming survey

Variable rate decision	N	Direction of change			Magnitude of change	
		De-crease	No change	In-crease	De-crease	In-crease
		Percent of respondents			Percent change	
Fertilizer	195	47	22	31	-25	32
Lime	172	66	14	20	-28	32
Seed	99	23	55	22	-11	48
Growth regulator	112	28	38	34	-20	23
Harvest aids	99	19	59	22	-16	17
Fungicide	69	5	79	17	-26	44
Herbicide	84	4	62	34	-16	23
Insecticide	81	13	59	28	-16	21

Irrigation	74	14	49	37	-11	53

Use of GPS Guidance

GPS guidance adopters described the type of system employed and the field operations for which they were used. Overall, 40.4% of survey respondents reported having adopted GPS guidance. Approximately 66% of those who adopted used an autosteer system whereas 34% of adopters used a lightbar system (data not shown). On average, adopters used GPS guidance for 2.5 different field operations. Systems were used most frequently for the spraying (by 79% of adopters), planting (62%), and tillage (59%) operations. Guidance was also used for cultivating (29%) and harvesting (19%) operations, but by fewer respondents.

PERCEPTIONS ABOUT PRECISION FARMING

Information Sources

Respondents indicated the sources they used to obtain information about precision farming, and then ranked their perceived usefulness from most important (rank = 1) to least important (rank = 7). If two or more sources were equally useful, respondents were to assign equal values. On average, precision farming adopters used 3.5 information sources whereas non-adopters used 2.6 sources (Table 7). For both adopters and non-adopters, other farmers and farm dealers were the two most frequently used information sources. University extension was the third most frequently used information source by adopters, but the fourth most frequent among non-adopters. Crop consultants, trade shows, and the internet were also used, but more by adopters than non-adopters. The relative ranking of information sources was nearly identical for adopters and non-adopters. Other farmers were ranked as most useful, followed by farm dealers, crop consultants, and university extension. Trade shows, the internet, and news/media were least useful.

Table 7. Information sources used to obtain precision farming information – 2009 Southern cotton precision farming survey

Information source	Non-adopters		Adopters	
	%	Rank[1]	%	Rank[1]
Farm dealer	55	2.1	75	2.1
Crop consultant	27	2.0	40	2.1
University extension	35	1.9	48	2.2
Other farmers	62	1.7	70	1.9
Trade shows	24	2.9	41	3.2
Internet	13	3.4	35	3.1
News/media	39	2.8	38	3.2
Total respondents	382		900	
Average number of sources	2.6		3.5	

[1] Lower ranking indicates more useful information sources.

Price and Value of a Cotton Yield Monitoring System

Adopters and non-adopters reported their best estimate for the purchase price of a cotton yield monitoring system. Responses ranged from a low of $0 to a maximum of $70,000 (data not shown). Adopters indicated an average purchase price of $12,571 (standard deviation, $477). Similarly, non-adopters reported an average price of $13,771 (standard deviation, $2,184). These average prices are approximately $1,500-1,900 above the list price of $10,980 for a cotton yield monitoring system that included a monitor, flow sensor kit for a 4-row picker, a GPS receiver, and GIS desktop computer software (John Deere, 2010).

Intent to Purchase a GPS Guidance System

Respondents also stated their intentions to purchase a GPS guidance system in the near future. Twenty percent of precision farming non-adopters indicated they did indeed intended to purchase a GPS guidance system within the next three years. By contrast, 48% of precision farming adopters reported a similar intent to purchase a GPS guidance system (data not shown).

University Outreach and Extension Services

The survey asked respondents about university outreach and extension services. When asked how many times they attended university presentations and/or educational events related to precision farming, adopters reported they had attended 3.5 events, on average, over the past five years. Non-adopters reported having attended 1.6 events, on average, over the same period. Nearly half (45%) of adopters reported having used a university publication to obtain information precision farming information in the past five years. By comparison, 17% of non-adopters reported having used such a source (data not shown).

RESPONDENT CHARACTERISTICS

Farm Characteristics

Respondents provided information on their land resources used for the production of cotton and other crops (Table 8). The average precision farming adopter planted more total crop acres and cotton acres than non-adopters in both 2007 and 2008. Precision farming adopters also had a larger share of cotton acres under irrigation than non-adopters, but owned a smaller share of their cotton acres farmed compared to non-adopters. Average dryland and irrigated cotton yields reported by precision farming adopters ranged from 60-100 lbs/acre above those reported by non-adopters (in 2007 and 2008).

Precision farming adopters reported greater yield variability within their typical farm field than did adopters (Table 9). For example, the average difference in dryland yields between the most and least productive field areas was 408 lb/ac for non-adopters but 462 lbs/acre for adopters. Similarly, for the typical irrigated

field, yield differences averaged 570 lbs/acre for non-adopters and 593 lbs/acre for adopters.

Table 8. Land resources in 2007 and 2008 as grouped by precision farming adoption status – 2009 Southern cotton precision farming survey

Variable	2007		2008	
	N	Mean	N	Mean
Precision farming adopters				
Total crop area (acres)	969	1126	890	1098
Cotton area (acres)	969	743	890	723
Percent cotton acres owned (%)	969	0.39	890	0.37
Percent cotton acres rented (%)	969	0.61	890	0.63
Percent cotton acres dryland (%)	969	0.65	890	0.64
Percent cotton acres irrigated (%)	969	0.35	890	0.36
Dryland cotton yield (lbs/acre)	781	752	679	713
Irrigated cotton yield (lbs/acre)	455	1178	426	1065
Precision farming non-adopters				
Total crop area (acres)	534	474	469	468
Cotton area (acres)	534	367	469	360
Percent cotton acres owned (%)	534	0.44	469	0.42
Percent cotton acres rented (%)	534	0.56	469	0.58
Percent cotton acres dryland (%)	534	0.76	469	0.77
Percent cotton acres irrigated (%)	534	0.24	469	0.23
Dryland cotton yield (lbs/acre)	437	677	364	618
Irrigated cotton yield (lbs/acre)	164	1103	151	1005

Table 9. Yield variability in a typical cotton field – 2009 Southern cotton precision farming survey

	Adopters			Non-adopters		
Variable	N	Yield	Std dev	N	Yield	Std dev
		lbs/acre	lbs/acre		lbs/acre	lbs/acre
Dryland cotton:						
Most productive 1/3	699	459	9.6	295	398	16.1
Average productive 1/3	699	682	10.6	295	585	15.3
Least productive 1/3	699	921	13.1	295	806	21.1
Irrigated cotton:						
Most productive 1/3	418	790	15.1	123	665	20.5
Average productive 1/3	418	1063	14.8	123	924	22.7
Least productive 1/3	418	1383	17.2	123	1235	29.4

Demographic Characteristics

Producers were queried about their age, farming experience, computer usage and other demographic characteristics (Table 10). On average, non-adopters were seven years older than adopters. Non-adopters also reported five more years of farming experience, on average, than did non-adopters. Approximately two-thirds of adopters used a computer for farm management compared to half that number of non-adopters. One in six adopters reported having used a computer in the field while less than one of ten of non-adopters did so. A larger percentage of adopters than non-adopters also reported having used agricultural and conservation easements on their farm properties. On average, precision farming adopters had one more year of formal education than did non-adopters. However, a slightly larger disparity occurred in terms of the highest degree received. Here, 44% of adopters reported having completed a college degree or higher whereas only 31% of non-adopters reported a similar achievement.

Both precision farming adopters and non-adopters indicated that income from farming was responsible for over half of their household income in 2007 (Table 10). However, 57% percent of non-adopter households earned a pre-tax household income of $99,000 or below (Table 11). By contrast, only 45% of adopter households reported pre-tax incomes in the same range. Similarly, the share of respondents with a pre-tax income of $200,000 or above was higher for adopters (27%) than non-adopters (17%).

Table 10. Demographic characteristics of precision farming adopters and non-adopters -- 2009 Southern cotton precision farming survey

Demographic characteristic	Adopters			Non-adopters		
	N	Mean	Std dev	N	Mean	Std dev
Age (Years)	953	53.1	0.47	505	61.2	0.60
Farming experience (years)	949	29.5	0.51	496	34.0	0.81
Computer for farm management (1 = yes)	958	0.64	0.02	507	0.29	0.02
Use laptop or other field computer (1 = yes)	959	0.16	0.01	510	0.03	0.01
Have conservation easement (1 = yes)	715	0.22	0.02	329	0.13	0.02
Have agricultural easement (1 = yes)	607	0.14	0.02	298	0.14	0.02
Education (years)	922	14.5	0.09	476	13.4	0.15
Have college degree or above (1 = yes)	953	0.44	0.01	501	0.31	0.02
Share of income from farming (%)	942	72.4	1.23	488	57.1	1.74

Table 11. Household incomes – 2009 Southern cotton precision farming survey

Income category	Adopters		Non-adopters	
	N	%	N	%
Under $50K	134	16.4	100	26.0
$50 to $99K	282	31.7	172	37.8
$100 to $149K	171	19.0	67	12.6
$150 to $199K	83	9.4	62	11.9
$200 to $499K	150	14.3	67	9.8
$Over 500K	99	9.2	16	2.0

SUMMARY AND CONCLUSIONS

The objectives of this study were to determine the status of cotton precision farming in twelve southern U.S. states, explore producer perceptions about precision farming, and compare farm and demographic characteristics. A mail survey of 13,579 cotton producers was conducted in early 2009. In total, 57% of respondents were classified as precision farming adopters.

Zone and grid soil sampling were the most widely used information gathering technologies, followed by yield monitoring with GPS and soil survey maps. Variable rate management decisions were made most frequently with fertility/lime inputs. Growth regulators and harvest aids were also commonly applied at variable rates using aerial and satellite imagery. Spraying, planting, and tillage were the most commonly reported field operations for GPS guidance.

Precision farming adopters and non-adopters shared similar perceptions about the relative usefulness of selected information sources, and provided similar estimates for the purchase price of a cotton yield monitoring system with GPS. On average, precision farming adopters worked more total and cotton crop acres, rented a larger share of their acreage, and had higher yields than did non-adopters. Similarly, adopters were on average younger, more educated, obtained a higher share of their income from farming. They also had higher rates of computer usage for farm management, both at home and in the field, than did non-adopters.

As new precision technologies and improved information becomes available, cotton producers will have expanded opportunities to increase profits. Future research by The Cotton Incorporated Economics of Precision Farming Working Group will continue utilizing this survey data to further appraise the present status and future prospects of cotton precision farming in the southern United States.

ACKNOWLEDGEMENTS

The authors thank Cotton Incorporated and their respective land grant institutions for research support. They also thank graduate students in Agricultural and Resource Economics at the University of Tennessee for assistance with the survey mailing and data entry. Mention of trade names or other proprietary marks

does not imply the approval of these products nor does it constitute endorsement by the authors or their respective institutions.

REFERENCES

Brackstone, G.J., and J.N.K. Rao. 1976. Estimating the Variance of Raking Ratio Estimators. Can. J. Stat. 16:47-55.

Cochran, R.L., R.K. Roberts, B.C. English, J.A. Larson, W.R. Goodman, S.L. Larkin, M.C. Marra, S.W. Martin, K.W. Paxton, W.D. Shurley, and J.M. Reeves. 2006. Precision farming by cotton producers in eleven states: Results from the 2005 Southern precision farming survey. Res. Rep. 01–06, Dep. Agric. and Resource Econ., Univ. Tennessee, Knoxville, TN.

Dillman, D.A. 1978. Mail and telephone surveys. John Wiley & Sons, New York.

John Deere, Inc. 2010. *John Deere Equipment Configurator*. Retrieved from http://www.deere.com/en_US/ag/index.html (last accessed Mar. 30, 2010).

Lohr, S. 1999. Sampling: Design and Analysis. Brooks/Cole, Pacific Grove, CA.

Mooney, D.F., B.C. English, M. Velandia, J.A. Larson, R.K. Roberts, D.M. Lambert, S.L. Larkin, M.C. Marra, R. Rejesus, S.W. Martin, K.W. Paxton, A. Mishra, E. Segarra, C. Wang, and J.M. Reeves. 2010a. Trends in Cotton Precision Farming: 2000-2008. Pp. 476-481. *In*, Proc. of the 2010 Beltwide Cotton Conf., New Orleans, LA, Jan. 5–8.

Mooney, D.F., R.K. Roberts, B.C. English, J.A. Larson, D.M. Lambert, M. Velandia, S.L. Larkin, M.C. Marra, R. Rejesus, S.W. Martin, K.W. Paxton, A. Mishra, E. Segarra, C. Wang, and J.M. Reeves. 2010b. Precision Farming by Cotton Producers in Twelve Southern States: Results from the 2009 Southern Cotton Precision Farming Survey. Dep. of Agric. and Resource Econ., Univ. Tennessee, Knoxville, TN. (forthcoming)

Roberts, R.K., B.C. English, J.A. Larson, R.L. Cochran, W.R. Goodman, S.L. Larkin, M.C. Marra, S.W. Martin, W.D. Shurley, and J.M. Reeves. 2002. Precision Farming by Cotton Producers in Six Southern States: Results from the 2001 Southern Precision Farming Survey. Res. Rep. 03–02, Dep. of Agric. and Resource Econ., Univ. Tennessee, Knoxville, TN.

Roberts, R., B. English, J. Larson, R. Cochran, S. Larkin, M. Marra, S. Martin, K.W. Paxton, W.D. Shurley, W.R. Goodman, and J.M. Reeves. 2006. Use of Precision Farming Technologies by Cotton Farmers in Eleven States. Pp. 288-295. *In*, Proc. of the 2006 Beltwide Conf., San Antonio, TX, Jan. 3–6.

USDA. 2007. 2007 Census of Agriculture. USDA, Nat. Agric. Statistics Serv., Washington, D.C.

USDA. 2010. Crop Production 2009 Summary. Document No. CR PR 2-1 (10). USDA, Nat. Agric. Statistics Serv., Washington, D.C.