Bulletin 1123 August 2002

Summary of Precision Farming Practices and Perceptions of Mississippi Cotton Producers

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Featuring results from the

2001 Southern Precision Farming Survey

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Sponsored by Cotton Incorporated and the respective land-grant universities.

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Executive Summary

Precision farming is being hailed as a set of new technologies that promise private economic gains and societal environmental benefits. These new 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. Reduction of input levels, increased efficiency of inputs, and proper timing of inputs can reduce costs while increasing yields and returns.

Extensive research has been conducted in low-value grain crops for which yield monitors have been commercialized. The use of precision technology for cotton (a higher valued crop) is more limited because accurate yield monitors have only recently become commercially available. Because cotton is an important high-value crop in Mississippi, an assessment of the use of precision farming practices, an investigation into the factors that influence adoption of precision farming technologies, and an evaluation of the likelihood that cotton producers will adopt newly developed yield monitoring systems would provide important information for Mississippi cotton producers and agribusinesses alike.

The adoption of precision farming technologies depends on the characteristics of the decision maker, the farm, and the cotton market. The 1997 Census of Agriculture revealed 1,700 cotton producers in Mississippi. Overall characteristics of Mississippi farms as reported in the 1997 Census were 65% full ownership of farm land, 96% family/partner ownership of the farming operation, and 3% corporate ownership. According to the census, 6.8% of the farms contained 1,000 acres or more. Planted acres of cotton in Mississippi have ranged from 950,000 to 1.3 million acres over the last five years. Statewide cotton yields have averaged 753 pounds per acre for the period 1996-2000. The future of precision farming in cotton production depends on how producers view this set of new technologies and how willing they are to improve current management practices.

This study had two objectives: (1) to determine Mississippi cotton producers' attitudes toward and current use of precision farming technologies; and (2) to examine Mississippi cotton producers' willingness to pay for a cotton yield monitoring system. A mail survey of cotton producers located in Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee was conducted in January and February of 2001 to establish the current use of precision farming technologies in these southeastern states. This report provides information dealing with the Mississippi portion of the survey.

Results indicate cotton producers are listening to crop consultants, university extension and research personnel, and farm dealers in making decisions about precision farming. Most responding cotton producers use computers for farm management decisions, and they believe precision farming will be profitable in the future. Those producers who adopt these technologies do so to increase profit. The top four precision farming technologies being used by adopters were soil survey maps, soil grid sampling, soil sampling by management zones, and variable rate fertilizer application. Responding producers indicated less willingness to purchase precision farming equipment (yield monitors) as price increased.

INTRODUCTION

The Mississippi State Planning Budgets (MSPB) show the cost of cotton production in Mississippi using conventional practices to be as much as $587 per acre, depending on soil type and irrigation practices. MSPB costs do not include land costs, overhead costs, or any return to management. With cotton prices extremely low, producers are continuously looking for ways to reduce these costs. Reduction of input levels, increased efficiency of inputs, and proper timing of the inputs may reduce costs while increasing yields and returns.

Precision farming is being hailed as a set of new technologies that promise private economic gains and societal environmental benefits. These new 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. Thus far, most producers have made only modest investments in precision farming technologies (Lowenberg-DeBoer, 1999).

A review of literature by Lambert and Lowenberg-DeBoer (2000) summarizes the profitability of precision farming. Seventy-three percent of the studies they reviewed found precision farming to be profitable. Early studies that investigated the economic potential of precision farming showed mixed results. Lowenberg-DeBoer et al. (1994) found site-specific management (i.e., precision farming) of phosphorous and potassium on corn to be unprofitable with the exception of fields with low soil tests. Beuerlein and Schmidt (1993) also determined that precision farming was unprofitable on corn and soybeans when managing phosphorus and potassium but acknowledged more efficient use of fertilizer as a resulting benefit. Fiez et al. (1994) suggested that precision farming is potentially profitable for managing nitrogen on wheat, while Malzer (1996) and Schnitkey et al. (1997) agreed it is profitable on the majority of corn and soybean field trials conducted for their studies where phosphorous and potassium were controlled. Hammond (1993) reported inconclusive results on the profitability of variable rate technology for potatoes when applying phosphorous and potassium. Mixed results concerning the profitability of variable rate technology when managing nitrogen on corn were reported by Snyder et al. (1997).

While these studies provide some insight into the economic value of precision agriculture, the fact remains that little is actually known about the economic value of this new technology. A search for precision agriculture economics via the AGRICOLA database returned only 18 publications in which these topics were mentioned within the last 10 years. It is evident even to some of the 18 authors that little economic analysis has been performed in precision farming. According to Leboeuf, in *HortTechnology*, "As valuable field experience increases (in Precision Agriculture), successful applications of management practices are being identified even though few are adequately documented with economic benefits."

Extensive research has been conducted in low-value grain crops for which yield monitors have been commercialized. The use of precision technology for cotton (a higher valued crop) is more limited because accurate yield monitors have only recently become commercially available. Because cotton is an important high-value crop in Mississippi, an assessment of the use of precision farming practices, an investigation into the factors that influence adoption of precision farming technologies, and an evaluation of the likelihood that cotton producers will adopt newly developed yield-monitoring systems would provide important information for Mississippi cotton producers and agribusinesses alike.

Cotton is produced in Mississippi on a wide range of soils with varying yield potentials. Topsoil, rooting depth, water-holding capacity, texture, and other soil characteristics vary within a field and can cause yields to vary across a field. Though accurate cotton yield monitors have only recently become commercially available, other precision farming technologies have been available to cotton farmers for some time. These precision farming services can be custom hired from consultants and vendors for a fee or implemented by the producers.

The adoption of precision farming technologies depends on the characteristics of the decision maker, the farm, and the cotton market. The 1997 Census of Agriculture revealed 1,700 cotton producers in Mississippi. Overall characteristics of Mississippi farms as reported in the 1997 Census were 65% full ownership of farm land, 96% family/partner ownership of the farming operation, and 3% corporate ownership. According to the census, 6.8% of the farms contained 1,000 acres or more. Planted acres of cotton in Mississippi have ranged from 950,000 to 1.3 million

acres over the last five years. 2001 was projected to have the largest planted acreage in some time; it was projected at 1.5 million acres. Statewide cotton yields have averaged 753 pounds per acre for the period 1996-2000.

The future of precision farming in cotton production depends on how producers view this set of new technologies and how willing they are to improve current management practices. Hudson and Hite suggest that while the newness of the technology may contribute to low adoption rates, the uncertainty surrounding the benefit-cost ratio is more likely the limiting factor to adoption of precision farming practices. Swinton and Lowenberg-DeBoer (1998) caution that the early profits of technology adoption will go only to those producers with strong technical and managerial skills. A need exists to assess producers' experiences with a variety of precision farming technologies and to determine what benefits they have received or expect to receive from using these technologies. Such an assessment is needed to appraise the present status and future prospects for adoption of precision farming technologies by cotton producers in Mississippi.

Objectives — This study had two main objectives: (1) to determine Mississippi cotton producers' attitudes toward and current use of precision farming technologies; and (2) to examine Mississippi cotton producers' willingness to pay for a cotton yield monitoring system.

METHODS

Survey Methods

A mail survey of cotton producers located in Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee was conducted in January and February of 2001 to establish the current use of precision farming technologies in these southeastern states. This report provides information dealing with the Mississippi portion of the survey.

A questionnaire was developed to query producers about their attitudes toward and use of precision farming technologies (Appendix 1). The questionnaire was previously pretested on two producers in Tennessee by the University of Tennessee researchers involved in this study, and their suggestions were incorporated into the final version. Following Dillman's 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. The initial mailing of the questionnaire was on January 16, 2001, and a reminder postcard was sent one week later on January 23, 2001. A follow-up mailing to producers not responding to previous inquiries was conducted three weeks later on February 15, 2001. The second mailing included a letter indicating the importance of the survey, the questionnaire, and a postage-paid return envelope. Producers were instructed to return their questionnaires without filling them out if they were not cotton producers.

A mailing list of 1,334 potential Mississippi cotton producers for the 1999-2000 season was furnished by the Cotton Board in Memphis, Tennessee (Skourpa, 2000). Of the 1,334 questionnaires mailed, 24 were returned undeliverable and 28 indicated they were not cotton farmers or had retired, giving a total of 1,282 cotton producers in Mississippi. Of those who responded, 262 individuals provided data. Assuming the remaining nonrespondents to the survey were active cotton producers, the usable response rate was 20%.

Questions for Adopters (Questions 1-19)

In question 1 of the questionnaire, producers were asked to indicate the number of years they had used precision farming technologies on cotton, corn, peanuts, rice, soybeans, tobacco, and wheat. If they had not used any of the technologies, they were instructed to proceed to question 20. The precision farming technologies included yield monitoring with global positioning systems (GPS); yield monitoring without GPS; yield monitoring without a yield monitor; grid soil sampling; management-zone soil sampling; remote sensing through aerial photography; remote sensing through satellite imagery; soil survey maps; mapping topography, slope, soil depth, and other field attributes; plant tissue testing; on-the-go sensing; and variable rate application of nitrogen, phosphorous, potassium, lime, seed, growth regulators, defoliants, fungicides, herbicides, insecticides, and irrigation. Producers were asked to identify the decision-making value of the technologies they used and the factors that prompted their decision to practice precision farming.

Producers were questioned about their soil sampling techniques, use of variable rate application technology to apply different inputs, and how variable rate application affected total input use and cotton yields. They were asked to list precision farming equipment they presently owned or leased and problems they encountered with the equipment.

For the precision farming technologies producers' had used or investigated, they were asked to rate the importance of several information sources in learning about those technologies. They were also asked to identify the off-farm precision farming services used or employed on the farm and the cost of hiring those services.

Producers who had used precision farming technologies were asked if they found them profitable on their fields. In the case of unprofitable precision farming techniques, producers were asked to list the technologies they planned to discontinue. Producers were also asked to indicate whether they experienced improvements in environmental quality through precision farming and to list those improvements observed.

Questions for Nonadopters (Questions 20-41)

Both adopters and nonadopters of precision farming were asked to offer their opinions on the future of precision farming, to indicate whether they would prefer to own or lease equipment, and to give their best estimate of the typical purchase price of a cotton yield monitoring system with GPS. They were asked to indicate their opinions regarding the importance of precision farming five years in the future.

Producers were asked to provide acreage data, primary county of farm, estimated yields for all crops grown in 1999 and 2000, and annual average yield variability of a typical field for each of the crops they grew. They were also queried on their cotton equipment, age, education, computer use, farm finances, and farm planning goals.

To obtain information about cotton producers' willingness to pay for a yield monitoring system (Objective 2), the mailing list from the Cotton Board was randomly divided into six equal groups with each group given a different dollar amount in the willingness to pay questions. The dollar amounts were $4,500, $6,000, $7,500, $9,000, $10,500, and $12,000. Respondents were asked in question 30 to indicate if they currently owned a cotton picker and the size of the picker. In question 31, they were asked to establish their willingness to purchase a cotton yield monitoring system for their existing cotton picker. Question 32 asked respondents to indicate if they were considering purchasing or leasing a new cotton picker and the size of the picker. The purpose of question 33 was to discover producers' willingness to purchase an optional cotton yield monitoring system for an additional cost if they were purchasing or leasing a new cotton picker. The price of a cotton yield monitoring system at the time of the survey was $9,200 for a system with a monitor, a GPS receiver, sensors on two chutes of a four- or five-row picker, and the ability to estimate lint yield within 4% of actual yields. The price of an additional sensor for a six-row picker was $1,285 (Ag Leader, 2000).

RESULTS

Results are presented in five sections. The first section compares several characteristics of the respondents and their farming operations with data from the 1997 Census of Agriculture (Mississippi results) and the National Agricultural Statistics Service. The second section presents information on the use of precision farming practices in Mississippi. Where appropriate, the responses of precision farming adopters and nonadopters are compared. In the third section, demographic and farm characteristics are compared for precision farming adopters and nonadopters. The final two sections present the characteristics of the typical precision farming technology adopter and nonadopter.

Comparisons of Survey Data with Secondary Data Sources

The distribution of cotton farmers across Mississippi counties reported in Table 1 (Appendix II) corresponded closely with the distribution of respondents across counties. In 1997, more than 70% of the cotton producers were located in the Delta region of Mississippi (U.S. Department of Agriculture). Of the responding farmers, 72% were from the Delta region of Mississippi.

The average age of a typical respondent was younger than the average age of cotton producers reported in the census. The average age of cotton farmers reported in the survey was 51 years. In 1997, the average age of Mississippi producers was 55 years (U.S. Department of Agriculture). Respondents ranged in age from 21 to 89 years.

In 1997, 77% of Mississippi cotton producers reported farming as their primary source of income (U.S. Department of Agriculture), compared with 83% of survey respondents.

Survey respondents reported planting averages of 913 and 962 acres of cotton in 1999 and 2000, respectively, compared with an average planted acreage of 559 acres in 1997 (U.S. Department of Agriculture). In 1999 and 2000, Mississippi cotton yields were estimated at 702 and 654 pounds per acre (Mississippi Agricultural Statistics Service), respectively, while survey respondents reported average yields of 750 and 700 pounds per acre, respectively. Thus, acreage reported by survey respondents were much higher in 1999 and 2000 than reported in the 1997 Census, but yields reported by respondents were much closer to estimates from the Mississippi Agricultural Statistics Service.

Adopter Responses about Precision Farming

Use of Precision Farming Technologies

Adopting producers were asked to indicate the number of years they had used each precision farming technology for cotton and other crops (survey question 1). Descriptive statistics about the number of years Mississippi producers have used some form of precision farming technology on fields of cotton, corn, soybeans, and wheat are reported in Tables 2-6. Based on the number of responses presented in Table 2, the top four technologies being used by adopters were soil survey maps, soil grid sampling, soil sampling by management zones, and variable rate fertilizer application. When considering the average years of use, these technologies were also among the most used with soybeans being the leading commodity followed by cotton.

Decision-Making Value of Technologies

Adopters were asked to rate the decision-making value of precision farming on a scale of 1 (not important) to 5 (very important) as presented in Table 7 (Appendix II) (survey question 2). “Improving yields” was ranked as the most important criteria for adopting precision farming practices. “Discovering the need for drainage” was also very important to the majority of adopters. “Quit farming a portion of a field or an entire field” was not very important to adopters. However, producers who have adopted precision farming technologies considered all the possible benefits of available technology at least moderately important by ranking all of the other items an average of three or better.

Factors Influencing Use of Precision Farming

Precision farming adopters were asked to rate on a scale of 1 (not important) to 5 (very important) several factors that went into their decision to adopt precision farming technologies (survey question 3). Adopters reported that profit was the most important factor prompting them to adopt precision farming with 74% of

respondents considering it very important and only 2% indicating it was not important to their decision (Table 8, Appendix II). The fear of being left behind was least likely to persuade producers to practice precision farming. Environmental benefits were also very important to adopters with 64% ranking them 4 or higher.

Soil Sampling Technologies

Questions 4 through 8 of the survey questioned adopting producers about their soil sampling practices. Forty-two percent of responding adopters did the majority of their soil sampling within management zones and 35% did grid soil sampling, but only 8% pulled cores from grids within management zones (Appendix II, Table 9). Fifteen percent of adopters used none of the three precision-sampling choices listed in question 4.

The majority (60%) of responding adopters in Mississippi used consultants to collect their soil samples (Appendix II, Table 9). Twenty-two percent used a fertilizer or chemical dealer to collect samples, while only 17% collected the samples themselves. Seventy percent of adopters pulled soil cores from around the center point of the grid or management zone, while only 30% of adopters collected cores randomly within a grid or management zone.

The average management zone size was 19 acres and ranged from 1-100 acres (Appendix II, Table 10). On average, 10 soil cores were taken per management zone, with a range of one to 100 cores per zone. The typical grid size for adopters averaged 11 acres and ranged from 1-40 acres. On average, six soil cores were taken per grid, ranging from zero to 30 cores.

Variable Rate Input Application Technologies

Cotton producers who had adopted some form of precision farming technology were asked in question 9 about their use of variable rate application technologies on cotton. The majority of adopters did not use variable rate application technologies on cotton (Appendix II, Table 11). Forty percent of responding adopters used variable rate phosphorus and potassium application, followed by variable rate lime application (30%), variable rate nitrogen application (25%), and variable rate growth regulator and defoliant application (18%). Few responding adopters had used variable rate technology for manure application, nematicide application, or irrigation (5% or less).

Of those responding adopters who used variable rate lime and/or phosphorus and potassium application, the majority (+63%) reported decreases in input usage (Appendix II, Table 11). Forty-five percent of responding adopters reported an increase in total input use with variable rate nitrogen application. Another 27% reported a decrease in inputs, while 27% saw no affect on total nitrogen use. Total growth regulator use also decreased with variable rate application for 100% of responding adopters, while 43% of adopters experienced a decrease in defoliant use.

Adopters were asked to indicate how their cotton yields changed following variable rate application (survey question 10). Thirty-nine percent of the responding adopters experienced an increase in yields, 14% reported a decrease, and 47% indicated no change in cotton yields (Appendix II, Table 12). Poor weather conditions in 1999 and 2000 may have affected yield responses. In survey question 11, adopters were asked to indicate the magnitude of the change in yields. Sixteen adopters reported an average increase of 32 pounds of lint per acre. Responses ranged from zero to 100 pounds (Appendix II, Table 12).

Precision Farming Equipment

Adopting producers were asked to list in question 12 any precision farming equipment they presently owned or leased, in what year it was purchased, and the purchase or lease price. Adopters were also given an opportunity to list any problems they may have encountered with the equipment. Yield monitors and GPS receivers were the most commonly listed products. Most of the equipment was purchased since 1998. Common problems listed included broken wires and the inability to receive GPS satellite signals. In general, very little information was reported on precision farming equipment.

Information Sources

In survey question 13, adopters were asked to rate the helpfulness (1 = not helpful to 5 = very helpful) of different information sources in learning about the precision farming technologies they had used or investigated. Average scores for farm dealers as a source of information were highest for learning about variable rate lime application (4.06), variable rate phosphorous and potassium application (3.95), and soil grid sampling (3.32) (Appendix II, Table 13). Information gathered from farm dealers was not helpful for mapping topography (1.70); variable rate herbicide application (1.80); plant tissue sampling (1.89); aerial photography (2.00);

satellite imagery (2.00); on-the-go sensing (2.00); variable rate growth regulator, defoliant, fungicide, and insecticide application (2.00); or soil survey maps (2.31).

In Table 14 (Appendix II), results show that crop consultants were most helpful in learning about soil sampling in management zones (4.69), grid soil sampling (4.48), variable rate nitrogen application (4.27), variable rate lime application (4.21), variable rate phosphorus and potassium application (4.21), and plant tissue sampling (4.07). Responders rated crop consultants as somewhat helpful in all the listed areas.

Adopters considered the Extension Service and university experts most helpful as sources of information in learning about soil survey maps (3.71); soil grid sampling (3.71); mapping topography, slope, soil depth, etc. (3.70); soil management zones (3.69); and variable rate insecticide application (3.67). These sources were least helpful in farmers' efforts to learn about yield monitoring with and without a yield monitor (Appendix II, Table 15).

Other farmers were not generally rated as helpful sources of information in learning about precision farming technologies. Average scores were highest for yield monitoring without GPS (3.29), yield monitoring with GPS (3.17), and soil grid sampling (2.57) (Appendix II, Table 16). Other farmers were reported as helpful in no other areas.

The majority of adopters indicated that trade shows were not helpful sources of information in learning about precision farming technologies (Appendix II, Table 17). Similarly, the Internet and news media were not considered helpful sources of information (Appendix II, Tables 18 and 19).

Table 20 (Appendix II) summarizes the average scores for sources of information about all precision farming technologies considered across all responding adopters. Crop consultants (3.62), Extension Service and university personnel (3.28), and farm dealers (2.58) were the most helpful. Other farmers (1.90), Internet (1.69), trade shows (1.38), and the news media (1.13) were the least helpful sources for learning about precision farming technologies.

Precision Farming Services

In question 14 of the survey, adopting producers were asked if they used the services of a farmers' cooperative, a technical consultant, a custom applicator, Extension Service, or other agencies to perform any precision farming task on their farms. Sixty-three percent of responding adopters had used off-farm precision farming services (Appendix II, Table 21). Precision-farming adopters who had used off-farm precision farming services were asked to identify the services they had used or employed and the cost of those services (survey question 15). The majority of adopters reported receiving management and technical advice concerning the precision farming technologies they used (Appendix II, Table 22). The largest majority (100%) of responding adopters received advice concerning grid soil sampling. The average cost of advice on grid soil sampling was $3.36 per acre. Average cost for advice on soil survey maps was $2.67 per acre; for variable rate nitrogen application, $2 per acre. Almost all responding adopters indicated that they would purchase the advice again.

The most popular custom services hired by adopters are presented in Table 23 (Appendix II). Grid soil sampling was most popular with 89% of those who had adopted this technology having hired this service. The average costs of custom hiring the services were $7.92 per acre for grid soil sampling, $7.11 per acre for variable rate phosphorous and potassium application, and $6.80 per acre for variable rate lime application. Most of the responding farmers indicated they would purchase the service again. Responders indicated they would not purchase services for GPS and variable rate nitrogen application again.

Changes in Profit and Environmental Quality

Questions 16 through 19 of the survey dealt with adopter perceptions about the economic and environmental consequences of precision farming. Seventy-two percent of responding adopters thought precision farming was profitable (question 16) on their fields (Appendix II, Table 24). Adopters who found precision farming unprofitable were given an opportunity in question 17 to list the technologies they planned to discontinue; however, few farmers responded and each gave a varied answer. Only 33% of adopters thought they had experienced an improvement in environmental quality (question 18) as a result of precision farming (Appendix II, Table 24). In question 19, adopters were given an opportunity to list the improvements in environmental quality they had observed. Among their responses were "less nitrogen use," "lower fertilizer rates," "less fertilizer run-off," "better drainage," "leaving out areas that are not profitable," "cheaper in the long run," "more no-till," and "less herbicide injury."

Future of Precision Farming

Questions 20, 21, and 23 asked all producers about the future of precision farming. They were asked in questions 20 and 21 if they thought precision farming would be profitable for them to use in the future, and if so, would they prefer to own or rent their equipment. Eighty-eight percent of adopting producers and 61% of nonadopting producers thought precision farming would be profitable for them to use in the future (Appendix II, Table 25). For those respondents who believed it would be profitable, 61% of adopters and 53% of nonadopters would prefer to own the precision farming equipment. Question 23 gave respondents an opportunity to rate the importance of precision farming for several crops five years in the future. The level of importance ranged from 1 (not important) to 5 (very important). Adopters consistently rated the importance of precision farming five years in the future higher than did nonadopters (Appendix II, Table 27). For cotton production, the average scores for adopters and nonadopters were 4.10 and 3.53, respectively; for corn production, they were 3.87 and 3.33, respectively; for soybean production, they were 3.48 and 2.89, respectively; for rice production, they were 3.96 and 3.01, respectively; and for wheat production, they were 3.39 and 2.52, respectively.

Perceived Price of a Yield Monitoring System

In question 22, producers were asked to report their best estimate of the typical purchase price for a cotton yield monitoring system with GPS for their area. The average purchase price given by adopters was $8,182, while the average price given by nonadopters was $7,441 (Appendix II, Table 26). These average perceived prices were less than the actual price ($9,200) at the time of the survey for a cotton yield monitoring system that included a monitor, a GPS receiver, and sensors on two chutes of a four- or five-row picker (Ag Leader Technology, 2001).

Willingness to Buy a Yield Monitoring System

In question 30, all cotton farmers were asked if they owned a cotton picker; if so, they were asked to indicate whether they owned a four-, five-, or six-row picker. The purpose of this question was to determine if the respondent was a candidate for retrofitting a yield monitoring system on an existing picker. Eighty-one percent of adopters and 86% of nonadopters owned a cotton picker (Appendix II, Table 28). Of the adopters who responded to the second part of question 30, 78% owned a four-row cotton picker, 13% owned a five-row picker, and 9% owned a six-row picker. Eighty-seven percent of responding nonadopters owned a four-row picker, 7% owned a five-row picker, and 5% owned a six-row picker.

Table 29 (Appendix II) reports respondents' willingness to purchase a yield monitoring system for their four- or five-row cotton picker at specified dollar amounts (survey question 31). Clearly, smaller percentages of respondents were willing to purchase the yield monitoring system and larger percentages were unwilling to purchase the system as the price increased. The percentage of respondents in the "Don't know" and "Don't own a four- or five-row picker" remained about the same as the price increased.

Survey question 32 asked all cotton farmers if they were considering purchasing or leasing a new cotton picker. The purpose of this question was to determine if the respondent was a candidate for purchasing an optional yield monitoring system with the new picker. Only 25% of responding adopters and 13% of responding nonadopters were considering purchasing or leasing a new picker (Appendix II, Table 28). Sixty percent of the responding adopters were considering purchasing or leasing a new four-row picker, 7% a five-row picker, and 33% a six-row picker. Fifty-eight percent of responding nonadopters were considering a four-row picker, 8% a five-row picker, and 34% a six-row picker.

Table 30 (Appendix II) reports respondents' willingness to purchase or lease an optional yield monitoring system when they purchase or lease a new four-, five-, or six-row cotton picker at specified dollar amounts (survey question 33). The data show a trend downward in the percentage of farmers who would be willing to purchase an optional yield monitoring system as the price increases. The trend upward in the percentage of respondents who were unwilling to purchase or lease the system is not as clear as in the case of retrofitting a yield monitoring system to an existing picker. In this case, the percentage of respondents in the "Don't know" and "Don't intend to purchase or lease a new picker" increases with the price. Nevertheless, the price of a cotton yield monitoring system appears to affect farmers' willingness to pay for the system.

Respondent and Farm Characteristics for Adopters and Nonadopters

Farm Characteristics

Respondents were asked to describe their farm in 2000 (questions 24 through 26). On average, precision farming adopters owned 1,434 acres, share rented 1,150 acres under a two-year or longer rental agreement, and cash rented 1,224 acres under a three-year rental agreement. The average nonadopter owned 1,045 acres, share rented 828 acres, and cash rented 1,053 acres for three years (Appendix II, Table 31).

Producers were asked to provide the county where the majority of their farm was located (survey question 27). The greatest numbers of responses for precision farming adopters came from Washington County (10 adopters), Leflore County (seven adopters), Bolivar County (five adopters), Coahoma County (five adopters), and Humphreys County (five adopters) (Appendix II, Table 1). Geographically, these responses correlate well with total producers responding to the survey from these counties; there is also a good correlation with the number of producers reported in the 1997 Census of Agriculture (USDA).

Producers reported acres planted and estimated yields for the crops they produced in 1999 and 2000 (survey question 28). On average, adopters planted 1,183 acres of cotton in 1999 with yield averaging 803 pounds per acre (Appendix II, Table 33). Nonadopters planted 821 acres per farm in 1999. Cotton yields averaged 732 pounds per acre for nonadopters, which was 71 pounds per acre less than adopters' average yield. In 2000 (Appendix II, Table 33), adopters planted 1,175 acres yielding 772 pounds per acre, while nonadopters planted 889 acres yielding 677 pounds per acre. In 1999 and 2000, yields and acreage planted to corn, soybeans, and wheat were, in general, higher for adopters than nonadopters (Appendix II, Tables 32 and 33).

Producers were asked to provide annual average yields for the most productive one-third, the average, and the least productive one-third of typical cotton, corn, soybean, and wheat fields they farmed (question 29). Adopters reported similar or higher yields with lower standard deviations than nonadopters for cotton in all three yield categories (Appendix II, Table 34). Reporting for other crops varied between categories.

Table 35 (Appendix II) presents producers' responses to survey question 34 concerning livestock. About the same percentage of adopters (11%) and nonadopters (17%) reported that they owned livestock. Only 8% of responding cotton producers applied manure to their fields, and this was divided evenly between adopters and nonadopters.

Respondent Characteristics

Producers were queried about their age, years of farming experience, education, and computer usage (survey questions 35 through 38). The average age (question 35) of a precision farming adopter was 51 years and ranged from 25 to 78 years. Nonadopters averaged 50 years of age, ranging from 21 to 89 years (Appendix II, Table 36). Precision farming adopters had farmed an average of 26 years, while nonadopters had farmed an average of 28 years (survey question 36). However, years of farming ranged from four to 57 years for adopters and three to 70 years for nonadopters (Appendix II, Table 36). The overwhelming majority of adopters (90%) and nonadopters (95%) completed high school (question 37). Adopters averaged more than three years of college, while nonadopters averaged more than two years (Appendix II, Table 37). The majorities of adopters (83%) and nonadopters (81%) owned a computer (question 38) (Appendix II, Table 38). Eighty percent of adopters used the computer for farm management, compared with 58% of nonadopters (question 38).

Question 39 asked cotton farmers if farming was their primary source of income (Appendix II, Tables 39, 40, and 41). Farming was the primary source of income for all precision farming adopters. Total household income in 2000 ranged from $50,000 to $149,999 for 53% of adopters and less than $50,000 for 15% of adopters. Eight percent of adopters had household incomes greater than $500,000 in 2000.

Farming was also the primary income source for most nonadopters. Total household income in 2000 ranged from $50,000 to $149,999 for 51% of adopters and less than $50,000 for 27% of adopters. Six percent of adopters had household incomes greater than $500,000 in 2000.

Producers indicated the one statement that best described their farm planning goal in question 40. Fifty-seven percent of adopters and 56% of nonadopters stated their farm planning goal was to acquire enough farm assets to generate sufficient income for family living (Appendix II, Table 42). Twenty-three percent of adopters wanted to expand the size of their operation by acquiring additional resources, and only 5% of the responding adopters were considering selling the farm and moving to a different career. Fifteen percent of nonadopters wanted to expand the size of their operation, 24% were thinking about retirement and transferring the farm to the next generation, and 5% were considering selling the farm.

CONCLUSIONS

The objectives of this study were (1) to determine Mississippi cotton producers' attitudes toward and current use of precision farming technologies and (2) to examine Mississippi cotton producers' willingness to pay for a cotton yield monitoring system. Cotton producers are confronted every day with information concerning the rapidly growing precision farming industry. Most responding cotton producers use computers for farm management decisions and believe precision farming will be profitable in the future. Those producers who adopt these technologies do so to increase profit. Cotton producers are listening to crop consultants, extension and research personnel at universities, and farm dealers in making decisions about precision farming. Responding adopters of precision farming practices planted more cotton acreage and reported higher yields per acre than nonadopters. The top four precision farming technologies being used by adopters were soil survey maps, soil grid sampling, soil sampling by management zones, and variable rate fertilizer application. Responding producers indicated less willingness to purchase precision farming equipment (yield monitors) as price increased. As more information becomes available, cotton producers will have greater opportunities to make more informed decisions about the use of these technologies on their farms. Findings from this and other studies that investigate the current use and future prospects of precision farming technologies are important to cotton producers because they provide the needed information for making better decisions.

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2001 Southern Precision Farming Survey

"Precision farming" involves collecting information about within-field variability in yields and crop needs to assist in determining appropriate input levels and applying that information to your farm fields. This may result in varying input levels within each field.

1. In the table below, write the **number of years you have used each technology on each crop**. If you have not used any of these technologies, leave the boxes blank and proceed to Question 20.

Technology	Cotton	Corn	Peanuts	Rice	Soybeans	Tobacco	Wheat
Yield monitoring – with GPS							
Yield monitoring – without GPS							
Yield monitoring – without a yield monitor							
Soil sampling – grid							
Soil sampling – management zone							
Remote sensing – aerial photos							
Remote sensing – satellite images							
Soil survey maps							
Mapping topography, slope, soil depth, etc.							
Plant tissue testing							
On-the-go sensing							
Variable rate nitrogen application							
Variable rate phosphorous and potassium application							
Variable rate lime application							
Variable rate seed application							
Variable rate growth regulator application							
Variable rate defoliant application							
Variable rate fungicide application							
Variable rate herbicide application							
Variable rate insecticide application							
Variable rate irrigation							

2. Rate the decision-making value of the technologies you have used by circling the number that indicates how important you thought the information was (1 = not important, 5 = very important).

Item	Not Important				Very Important
Discovering a need for drainage	1	2	3	4	5
Discovering a need for leveling	1	2	3	4	5
Discovering a need for improved soil tilth	1	2	3	4	5
Maintaining a record of field conditions	1	2	3	4	5
Conducting rental negotiations	1	2	3	4	5
Deciding on the purchase of crop insurance (or establishing crop insurance units)	1	2	3	4	5
Maintaining better yield records	1	2	3	4	5
Maintaining better soil test records	1	2	3	4	5
Maintaining better financial records	1	2	3	4	5
Improving yields	1	2	3	4	5
Reducing N use	1	2	3	4	5
Reducing P&K use	1	2	3	4	5
Reducing herbicide use	1	2	3	4	5
Reducing insecticide use	1	2	3	4	5
Reducing plant growth regulator use	1	2	3	4	5
Reducing fungicide use	1	2	3	4	5
Reducing defoliant use	1	2	3	4	5
Quit farming a portion of a field or an entire field	1	2	3	4	5

3. What was your decision to practice precision farming prompted by? (Rate each item from 1 to 5)

Item	Not Important				Very Important
Profit	1	2	3	4	5
Environmental benefits	1	2	3	4	5
Be at the forefront of agricultural technology	1	2	3	4	5
Fear of being left behind	1	2	3	4	5

4. Please check the one item below that describes how you do the majority of your soil sampling.

Management zones _____ Grids within management zones _____
Grids _____ None of the other three choices _____

If you checked “None of the other three choices,” skip to question 9.

5. What is your average management zone size? _____ acres; typical grid size? _____ acres

6. On average, how many soil cores were taken per management zone? _____; per grid? _____

7. How were cores collected? (Check the one that applies)

_____ Randomly within a grid or management zone
_____ Around the center point of the grid or management zone

8. Who collected the soil samples? (Please check the best item)

Self _____ Consultant _____ Fertilizer or Chemical Dealer _____

9. For your **cotton** fields only, please provide the following information.

Input	Did you use variable rate application technology to apply? (Yes or No)	If you used variable rate technology, how did it affect total input use? (Increase, Decrease, Same)
N fertilizer		
P&K fertilizer		
Lime		
Manure application		
Seed		
Herbicide		
Insecticide		
Nematicide		
Irrigation		
Fungicide		
Growth regulator		
Defoliant		

10. Following variable rate application, how did your **cotton yields** change? (Check one)
Increase_____ Decrease _____ Stayed the same _____

11. If your **cotton yields** changed, by approximately how much did they change? _____ lint (lb/acre)

12. If you presently **own or lease** any precision farming equipment, please list the equipment and fill out the table; otherwise go to question 13.

Equipment Name	If equipment is owned		If leased, Lease rate? $ per acre	List any problems encountered.
	Year Purchased	Purchase Price ($)		
a.				
b.				
c.				
d.				
e.				

13. For only those precision farming technologies you have used or investigated, please rate the importance of each information source in learning about the precision farming technology by writing a number from 1 to 5 in the corresponding box (1 = not helpful to 5 = very helpful).

Precision Farming Technology	Information Sources						
	Farm Dealers	Crop Consultants	Extension/ Universities	Other Farmers	Trade Shows	Internet	News Media
Yield monitoring – with GPS							
Yield monitoring – without GPS							
Yield monitoring – without a yield monitor							
Soil sampling – Grid							
Soil sampling – Management Zone							
Remote sensing – aerial photos							
Remote sensing – satellite images							
Soil survey maps							
Mapping topography, slope, soil depth, etc.							
Plant tissue testing							
On-the-go sensing							
Variable rate nitrogen application							
Variable rate phosphorous and potassium application							
Variable rate lime application							
Variable rate seed application							
Variable rate growth regulator application							
Variable rate defoliant application							
Variable rate fungicide application							
Variable rate herbicide application							
Variable rate insecticide application							
Variable rate irrigation							

14. Did you **use the services of** a farmers' cooperative, a technical consultant, a custom applicator, extension service, etc. to perform any precision farming task on your farm? Yes _____ No _____

If "Yes", go to question 15; if "No", go to question 16.

15. In the table below, please identify which services you used or employed and the cost of these services.

Precision Farming Technology	Management and Technical Advice			Custom Services Hired		
	Did you receive advice? (yes or no)	What was the per acre cost?	Will you purchase this service again? (yes or no)	Did you hire this service? (yes or no)	What was the per acre cost?	Will you purchase this service again? (yes or no)
Yield monitoring – with GPS						
Yield monitoring – without GPS						
Yield monitoring – without a yield monitor						
Soil sampling – Grid						
Soil sampling – Management Zone						
Remote sensing – aerial photos						
Remote sensing – satellite images						
Soil survey maps						
Mapping topography, slope, soil depth, etc.						
Plant tissue testing						
On-the-go sensing						
Variable rate nitrogen application						
Variable rate phosphorous and potassium application						
Variable rate lime application						
Variable rate seed application						
Variable rate growth regulator application						
Variable rate defoliant application						
Variable rate fungicide application						
Variable rate herbicide application						
Variable rate insecticide application						
Variable rate irrigation						

16. Do you find precision farming profitable on your fields? Yes _____ No _____

17. If precision farming has not been profitable for you, which technologies (if any) do you plan to discontinue? List them _____

18. Have you experienced any improvements in environmental quality through the use of precision farming technologies? Yes _____ No _____

19. If you said yes to question 18, please list the improvements you have observed.
    a. _____ c. _____
    b. _____ d. _____

Resume here

20. Do you think it would be profitable for you to use precision-farming technologies in the future? Yes _____ No _____

21. If you believe it would be profitable, would you prefer to own or rent your equipment? Own _____ Rent _____

22. What is your best estimate of the typical purchase price of the following precision farming technology in your area? Cotton yield monitoring system with GPS $_____

23. **For each crop you grow** listed in the table below, please circle how important you believe precision farming will be five years from now in your state (1 = not important, 5 = very important).

Item	Not Important				Very Important
Cotton	1	2	3	4	5
Corn	1	2	3	4	5
Peanuts	1	2	3	4	5
Rice	1	2	3	4	5
Soybeans	1	2	3	4	5
Tobacco	1	2	3	4	5
Wheat	1	2	3	4	5

24. Your 2000 farm size? Acres owned ____ ; Acres share rented ____ ; Acres cash rented ____

25. If you cash rent, what is the length of your typical cash rental agreement? _____year(s)

26. If you share rent, what is the length of your typical share rental agreement? _____year(s)

27. In what county is most of your farm located? _____

28. Please give the acres planted and estimated yields for each crop you grew in 1999 and 2000.

	1999		2000	
Crops	Acres Planted	Yield	Acres Planted	Yield
Cotton		lb		lb
Corn		bu		bu
Peanuts		lb		lb
Rice		cwt		cwt
Soybeans		bu		bu
Tobacco		lb		lb
Wheat		bu		bu

29.Please tell us about the annual average yield variability of a typical field that you farm for each of the crops that you grow.

Give estimated yield for the following portions of the field.	Cotton Lb/acre	Corn Bu/acre	Peanuts Lb/acre	Rice Cwt/acre	Soybeans Bu/acre	Tobacco Cwt/acre	Wheat Bu/acre
Least productive 1/3							
Average yield							
Most productive 1/3							

30. Do you currently own a cotton picker? Yes _____ No _____
If yes, check the ones you own. 4-row _____, 5-row _____, 6-row _____

31. **4 or 5-row cotton pickers owned by farmers** can be equipped with a yield monitoring system that includes a monitor, a GPS receiver, sensors on two chutes, and the ability to estimate yields within 4% of actual yields. Would you purchase the yield monitoring system for your 4 or 5-row picker for $9,000 installed? Yes ____ No ____ Don't know ___Don't own a 4 or 5-row picker ___(Check one)

32. Are you thinking about purchasing/leasing a new cotton picker? Yes ____ No ____
If yes, check the ones you are thinking about purchasing/leasing. 4-row __, 5-row __, 6-row__

33. When a new cotton picker is purchased/leased**, a yield monitoring system can be purchased/leased as an option for an additional cost. Would you purchase an optional yield monitoring system that adds $9,000 to the purchase price of a new 4 or 5-row picker (or a corresponding increase in the lease rate), or $10,285 to the purchase price of a new 6-row picker ($1,285 more for an additional sensor for the larger picker)? Yes ___ No ___ Don't know ___ Don't intend to purchase/lease a new picker ___ (Check one)**

34. Do you own livestock? Yes ___ No ___ Do you apply manure on your fields? Yes ___ No___

Please answer the following questions about the primary decision maker on the farm. Answers to all questions will remain strictly confidential.

35. Age? _____

36. Number of years farming? _____

37. Did you complete high school? _____
If yes, how many years did you go to college? _____

38. Do you own a computer? Yes ___No ___ Do you use it for farm management? Yes __ No __

39. Is farming your primary source of household income? Yes _____ No _____

40. Please check the one statement that best describes your farm planning goal.
___ I want to acquire enough farm assets to generate sufficient income for family living?
___ I want to expand the size of operation through acquiring additional resources?
___ I am thinking about retirement and transfer of farm to the next generation?
___ I am considering selling the farm and moving on to a different career?

41 Please check the category that best reflects your total estimated household income from both farm and non-farm sources in 2000.

_____ Less than $50,000 _____ $100,000 to $149,999 _____ $200,000 to $499,999

_____ $50,000 to $99,999 _____ $150,000 to $199,999 _____ $500,000 or greater

42. What percent of your household income is from farming? _____%

Appendix II: Tables of Results

Table 1. Primary county of cotton farm business reported by primary decision maker for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

County	1997 Census of Agriculture[2]	Number of usable surveys	Precision farming adopters	Precision farming nonadopters
Benton	9 (.6%)[3]	1 (.4%)	0	1 (.6%)
Bolivar	97 (6%)	18 (7%)	5 (8%)	13 (7%)
Calhoun	67 (4%)	2 (.8%)	1	2 (1%)
Carroll	31 (2%)	4 (2%)	2 (3%)	2 (1%)
Chickasaw	11 (.7%)	3 (1%)	0	3 (2%)
Claiborne	3 (.2%)	2 (.8%)	2 (3%)	1 (.6%)
Coahoma	92 (6%)	16 (7%)	5 (8%)	11 (4%)
Copiah	4 (.2%)	1 (.4%)	0	1 (.6%)
DeSoto	18 (1%)	2 (.8%)	0	2 (1%)
Forrest	1 (0%)	1 (.4%)	0	1 (.6%)
George	5 (.2%)	3 (1%)	0	3 (2%)
Greene	4 (.2%)	1 (.4%)	0	1 (.6%)
Hinds	28 (2%)	3 (1%)	0	3 (2%)
Holmes	57 (4%)	10 (4%)	3 (5%)	7 (4%)
Humphreys	93 (6%)	17 (7%)	6 (10%)	11 (4%)
Issaquena	29 (2%)	4 (2%)	0	4 (2%)
Itawamba	7 (.4%)	2 (.8%)	0	2 (1%)
Lafayette	16 (1%)	1 (.4%)	0	1 (.6%)
Leake	9 (.6%)	1 (.4%)	1	0
Leflore	107 (7%)	26 (11%)	7 (11%)	19 (10%)
Lowndes	18 (1%)	5 (2%)	0	5 (3%)
Madison	42 (3%)	7 (3%)	2 (3%)	5 (3%)
Monroe	27 (2%)	4 (2%)	0	4 (2%)
Montgomery	36 (2%)	3 (2%)	0	3 (2%)
Noxubee	14 (.9%)	4 (2%)	0	4 (2%)
Panola	53 (3%)	4 (2%)	2 (3%)	2 (1%)
Pontotoc	17 (1%)	4 (2%)	0	4 (2%)
Prentiss	8 (.6%)	1 (.4%)	0	1 (.6%)
Quitman	56 (4%)	7 (3%)	4 (6%)	3 (2%)
Rankin	15 (1%)	2 (.8%)	0	2 (1%)
Sharkey	41 (3%)	10 (4%)	2	8 (4%)
Sunflower	81 (5%)	10 (4%)	3 (2%)	7 (4%)
Tallahatchie	93 (6%)	5 (2%)	4	1 (.6%)
Tate	30 (2%)	2 (.8%)	0	2 (1%)
Tippah	5 (.5%)	1 (.4%)	0	1 (.6%)
Tunica	35 (2%)	8 (3%)	5 (8%)	3 (2%)
Union	13 (.9%)	1 (.4%)	0	1 (.6%)
Warren	14 (.9%)	1 (.4%)	0	1 (.6%)
Washington	123 (8%)	30 (12%)	10 (16%)	20 (11%)
Webster	53 (3%)	3 (1%)	0	3 (2%)
Yazoo	102 (7%)	13 (5%)	4 (6%)	9 (5%)
Total	1564 (+/-100%)	244 (+/-100%)	62 (+/-100%)	182 (+/-100%)

[1]Survey question 27.
[2]Reported in the 1997 Census of Agriculture, USDA.
[3]Numbers in parenthesis indicate the percentage of respondents who gave the associated answer.

Table 2. Years of experience with alternative precision farming technologies for cotton reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Average	Standard deviation	Minimum	Maximum
		years	*years*	*years*	*years*
Yield monitoring — with GPS [2]	8	1.63	.92	1	3
Yield monitoring — without GPS	3	4	1	3	5
Yield monitoring — without a yield monitor	15	12.47	9.36	2	25
Soil sampling — grid	23	2.96	1.94	1	7
Soil sampling — management zone	23	12.43	7.5	1	25
Remote sensing — aerial photos	2	14	15.56	3	25
Remote sensing — satellite images	2	12.5	10.61	5	20
Soil survey maps	27	19.67	9.97	1	40
Mapping topography, slope, soil depth, etc.	7	14.71	8.10	3	25
Plant tissue testing	17	6.05	3.49	1	10
On-the-go sensing	3	7.33	5.51	1	11
Variable rate nitrogen application	13	4.31	3.15	1	10
Variable rate phosphorous and potassium application	20	3.45	2.98	1	10
Variable rate lime application	14	4.07	3.58	1	11
Variable rate seed application	5	7	4.3	1	11
Variable rate growth regulator application	11	7.36	3.96	2	15
Variable rate defoliant application	6	11	4.56	7	20
Variable rate fungicide application	4	7.75	4.57	1	11
Variable rate herbicide application	10	5.9	4.12	2	12
Variable rate insecticide application	4	8.25	3.60	3	11
Variable rate irrigation	3	7	4.36	2	10

[1]Survey question 1.
[2]Global positioning system.

Table 3. Years of experience with alternative precision farming technologies for corn reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Average	Standard deviation	Minimum	Maximum
		years	*years*	*years*	*years*
Yield monitoring — with GPS [2]	6	2.83	1.17	1	4
Yield monitoring — without GPS	10	3.20	1.93	1	5
Yield monitoring — without a yield monitor	5	8.2	5.45	4	17
Soil sampling — grid	10	3	2	1	7
Soil sampling — management zone	11	10	7.25	1	25
Remote sensing — aerial photos	1	25		25	25
Remote sensing — satellite images	0	0	0	0	0
Soil survey maps	10	14.50	11.33	1	35
Mapping topography, slope, soil depth, etc.	1	2		2	2
Plant tissue testing	0	0	0	0	0
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	3	5.33	4.16	2	10
Variable rate phosphorous and potassium application	6	3.5	3.33	1	10
Variable rate lime application	6	3.83	3.25	1	10
Variable rate seed application	0	0	0	0	0
Variable rate growth regulator application	0	0	0	0	0
Variable rate defoliant application	0	0	0	0	0
Variable rate fungicide application	0	0	0	0	0
Variable rate herbicide application	0	0	0	0	0
Variable rate insecticide application	0	0	0	0	0
Variable rate irrigation	0	0	0	0	0

[1]Survey question 1.
[2]Global positioning system.

Table 4. Years of experience with alternative precision farming technologies for soybeans reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Average	Standard deviation	Minimum	Maximum
		years	*years*	*years*	*years*
Yield monitoring — with GPS[2]	8	2.25	1.04	1	4
Yield monitoring — without GPS	5	1.2	.45	1	2
Yield monitoring — without a yield monitor	8	15.13	9.42	3	25
Soil sampling — grid	9	8.44	8.28	1	25
Soil sampling — management zone	11	14	8.61	1	25
Remote sensing — aerial photos	1	25	0	25	25
Remote sensing — satellite images	1	2	0	2	2
Soil survey maps	17	22.71	9.99	3	40
Mapping topography, slope, soil depth, etc.	3	17.67	12.70	3	25
Plant tissue testing	0	0	0	0	0
On-the-go sensing	1	11	0	11	11
Variable rate nitrogen application	2	6.5	3.54	4	9
Variable rate phosphorous and potassium application	3	2.67	.58	2	3
Variable rate lime application	6	7.17	7.08	2	20
Variable rate seed application	3	6	2.65	4	9
Variable rate growth regulator application	1	3	0	3	3
Variable rate defoliant application	1	7	0	7	7
Variable rate fungicide application	1	11	0	11	11
Variable rate herbicide application	1	30	0	30	30
Variable rate insecticide application	0	0	0	0	0
Variable rate irrigation	0	0	0	0	0

[1]Survey question 1.
[2]Global positioning system.

Table 5. Years of experience with alternative precision farming technologies for wheat reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Average	Standard deviation	Minimum	Maximum
		years	*years*	*years*	*years*
Yield monitoring — with GPS[2]	4	2.25	1.50	1	4
Yield monitoring — without GPS	6	1.33	.82	1	3
Yield monitoring — without a yield monitor	3	16.67	10.41	5	25
Soil sampling — grid	3	11.33	11.85	4	25
Soil sampling — management zone	5	12.2	7.19	1	20
Remote sensing — aerial photos	0	0	0	0	0
Remote sensing — satellite images	0	0	0	0	0
Soil survey maps	5	16.6	8.38	3	25
Mapping topography, slope, soil depth, etc.	1	25	0	25	25
Plant tissue testing	0	0	0	0	0
On-the-go sensing	1	8	0	8	8
Variable rate nitrogen application	0	0	0	0	0
Variable rate phosphorous and potassium application	2	3	1.41	2	4
Variable rate lime application	1	2	0	2	2
Variable rate seed application	1	8	0	8	8
Variable rate growth regulator application	1	8	0	8	8
Variable rate defoliant application	0	0	0	0	0
Variable rate fungicide application	1	8	0	8	8
Variable rate herbicide application	1	8	0	8	8
Variable rate insecticide application	0	0	0	0	0
Variable rate irrigation	0	0	0	0	0

[1]Survey question 1.
[2]Global positioning system.

Table 6. Years of experience with alternative precision farming technologies for rice reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Average	Standard deviation	Minimum	Maximum
		years	*years*	*years*	*years*
Yield monitoring — with GPS[2]	3	2.33	.58	2	3
Yield monitoring — without GPS	7	3.29	1.7	1	5
Yield monitoring — without a yield monitor	0	0	0	0	0
Soil sampling — grid	1	4	0	4	4
Soil sampling — management zone	4	11.50	8.10	1	20
Remote sensing — aerial photos	0	0	0	0	0
Remote sensing — satellite images	0	0	0	0	0
Soil survey maps	3	21.67	2.89	20	25
Mapping topography, slope, soil depth, etc.	1	25	0	25	25
Plant tissue testing	2	10	0	10	10
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	1	20	0	20	20
Variable rate phosphorous and potassium application	1	2	0	2	2
Variable rate lime application	2	15	7.07	10	20
Variable rate seed application	0	0	0	0	0
Variable rate growth regulator application	1	20	0	20	20
Variable rate defoliant application	1	20	0	20	20
Variable rate fungicide application	0	0	0	0	0
Variable rate herbicide application	1	20	0	20	20
Variable rate insecticide application	1	20	0	20	20
Variable rate irrigation	0	0	0	0	0

[1]Survey question 1.
[2]Global positioning system.

Table 7. Value of precision farming technologies in management decision making reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Management decision	Number of responses	Level of importance[2]				
		1	2	3	4	5
Discovering a need for drainage	62	3 (5%)[3]	0	6 (10%)	14 (23%)	39 (63%)
Discovering a need for leveling	59	4 (7%)	2 (3%)	13 (22%)	16 (27%)	24 (41%)
Discovering a need for improved soil tilth	61	5 (8%)	4 (7%)	12 (20%)	16 (26%)	24 (39%)
Maintaining a record of field conditions	60	7 (12%)	5 (8%)	12 (20%)	16 (27%)	20 (33%)
Conducting rental negotiations	58	10 (17%)	3 (5%)	17 (29%)	13 (22%)	15 (26%)
Deciding on the purchase of crop insurance (or establishing crop insurance units)	60	8 (13%)	6 (10%)	14 (23%)	17 (28%)	15 (25%)
Maintaining better yield records	60	1 (2%)	0	6 (10%)	25 (42%)	28 (47%)
Maintaining better soil test records	64	0	1 (2%)	12 (19%)	23 (36%)	28 (44%)
Maintaining better financial records	61	2 (3%)	3 (5%)	6 (10%)	18 (30%)	32 (52%)
Improving yields	70	0	2 (3%)	2 (3%)	14 (20%)	52 (74%)
Reducing N use	61	1 (2%)	3 (5%)	16 (26%)	22 (36%)	19 (31%)
Reducing P&K use	62	2 (3%)	7 (11%)	15 (24%)	18 (29%)	20 (32%)
Reducing herbicide use	61	1 (2%)	5 (8%)	15 (25%)	21 (34%)	19 (31%)
Reducing insecticide use	59	3 (5%)	6 (10%)	13 (22%)	19 (32%)	18 (31%)
Reducing plant growth regulator use	56	3 (5%)	7 (13%)	19 (34%)	14 (25%)	13 (23%)
Reducing fungicide use	57	7 (12%)	10 (18%)	17 (30%)	13 (23%)	10 (18%)
Reducing defoliant use	56	6 (11%)	7 (13%)	15 (27%)	19 (34%)	9 (16%)
Quit farming a portion of a field or an entire field	55	14 (25%)	9 (16%)	16 (29%)	6 (11%)	10 (18%)

[1]Survey question 2.
[2]Level of importance ranges from not important (1) to very important (5).
[3]Numbers in parentheses indicate the approximate percentage of respondents who gave the associated answer.

Table 8. Factors that influenced the adoption of precision farming practices reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Item	Number of responses	Level of importance[2]				
		1	2	3	4	5
Profit	65	1 (2%)[3]	1 (2%)	1 (2%)	14 (22%)	48 (74%)
Environmental benefits	58	1 (2%)	5 (9%)	15 (26%)	22 (38%)	15 (26%)
To be at the forefront of agricultural technology	57	13 (23%)	9 (16%)	15 (26%)	10 (18%)	10 (18%)
Fear of being left behind	59	25 (42%)	9 (15%)	12 (20%)	7 (12%)	6 (10%)

[1]Survey question 3.
[2]Level of importance ranges from not important (1) to very important (5).
[3]Numbers in parentheses indicate the approximate percentage of respondents who gave the associated answer.

Table 9. Soil sampling in Mississippi reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Item	Number of responses	Percentages
How do you do the majority of your soil sampling? [1]	**72 Total**	**100**
Management zones	30	42
Grids	25	35
Grids within management zones	6	8
None of the other three choices	11	15
Who collects the soil samples? [2]	**58 Total**	**100**
Self	10	17
Consultant	35	60
Fertilizer of chemical dealer	13	22
How were the cores collected? [3]	**53 Total**	**100**
Randomly within a grid or management zone	16	30
Around the center point of the grid or management zone	37	70

[1]Survey question 4.
[2]Survey question 8.
[3]Survey question 7.

Table 10. Average management zone and grid sizes reported by Mississippi cotton farms — 2001 Precision Farming Survey.

Item	Number of responses	Average	Standard deviation	Minimum	Maximum
Average management zone size? (acres)[1]	37	19.30	22.51	1	100
Soil cores taken per management zone[2]	34	9.85	17.60	1	100
Typical grid size (acres)[1]	28	11.36	10.85	1	40
Soil cores taken per grid[2]	24	5.71	7.14	0	30

[1]Survey question 5.
[2]Survey question 6.

Table 11. Use of variable rate application technology on cotton fields reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Input	Did you use variable rate technology to apply?			If so, how did it affect total input use?			
	Responses	Yes	No	Responses	Increase	Decrease	Same
N fertilizer	68	16 (25%)[2]	52 (75%)	11	5 (45%)	3 (27%)	3 (27%)
P&K fertilizer	68	27 (40%)	41 (60%)	24	3 (13%)	15 (63%)	6 (25%)
Lime	67	20 (30%)	47 (70%)	17	4 (24%)	11 (65%)	2 (12%)
Manure application	59	3 (5%)	56 (95%)	0	0	0	0
Seed	61	6 (10%)	55 (90%)	0	1 (33%)	2 (67%)	0
Herbicide	64	8 (13%)	53 (87%)	9	4 (44%)	5 (56%)	0
Insecticide	61	8 (13%)	53 (87%)	5	1 (20%)	3 (60%)	1 (20%)
Nematicide	58	1 (2%)	57 (98%)	1	0	1 (100%)	0
Irrigation	60	3 (5%)	57 (97%)	3	2 (67%)	1 (33%)	0
Fungicide	60	2 (3%)	58 (97%)	0	0	0	0
Growth regulator	62	11 (18%)	51 (82%)	10	0	10 (100%)	0
Defoliant	64	11 (17%)	53 (83%)	7	3 (43%)	3 (43%)	1 (14%)

[1]Survey question 9.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 12. The change in cotton yields following variable rate application reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey

	Responses	Increase	Decrease	Same
Following variable rate application, how did your cotton yields change?[1]	36	14 (39%)[2]	5 (14%)	17 (47%)
	Responses	**Average**	**Minimum**	**Maximum**
If your cotton yields changed, by approximately how much did they change? (lb lint/acre)[3]	16	32	0	100

[1]Survey question 10.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.
[3]Survey question 11.

Table 13. Importance of farm dealers as an information source about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	24	7 (29%)[3]	5 (21%)	3 (13%)	4 (17%)	5 (21%)
Yield monitoring — without GPS	8	2 (25%)	2 (25%)	0	1 (13%)	3 (38%)
Yield monitoring — without a yield monitor	5	3 (60%)	0	0	0	2 (40%)
Soil sampling — grid	22	8 (36%)	0	1 (5%)	3 (14%)	10 (45%)
Soil sampling — management zone	10	3 (30%)	1 (10%)	1 (10%)	0	5 (50%)
Remote sensing — aerial photos	6	4 (67%)	0	1 (17%)	0	1 (17%)
Remote sensing — satellite images	6	4 (67%)	0	1 (17%)	0	1 (17%)
Soil survey maps	13	8 (62%)	0	1 (8%)	1 (8%)	3 (23%)
Mapping topography, slope, soil depth, etc.	10	7 (70%)	1 (10%)	1 (10%)	0	1 (10%)
Plant tissue testing	9	6 (67%)	0	2 (22%)	0	1 (11%)
On-the-go sensing	6	4 (67%)	0	1 (17%)	0	1 (17%)
Variable rate nitrogen application	10	3 (30%)	0	2 (20%)	1 (10%)	4 (40%)
Variable rate phosphorous and potassium application	20	4 (20%)	0	2 (10%)	1 (5%)	13 (65%)
Variable rate lime application	16	3 (19%)	0	1 (6%)	1 (6%)	11 (69%)
Variable rate seed application	7	3 (43%)	0	1 (14%)	0	3 (43%)
Variable rate growth regulator application	6	4 (67%)	0	1 (17%)	0	1 (17%)
Variable rate defoliant application	4	3 (75%)	0	0	0	1 (25%)
Variable rate fungicide application	4	3 (75%)	0	0	0	1 (25%)
Variable rate herbicide application	5	4 (80%)	0	0	0	1 (20%)
Variable rate insecticide application	4	3 (75%)	0	0	0	1 (25%)
Variable rate irrigation	4	2 (50%)	0	0	0	2 (50%)

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.
[4]Not reported to avoid disclosure.

Table 14. Importance of crop consultants as an information source about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	24	10 (42%)[3]	2 (8%)	2 (8%)	3 (13%)	7 (29%)
Yield monitoring — without GPS	10	4 (40%)	0	0	2 (20%)	4 (40%)
Yield monitoring — without a yield monitor	7	3 (43%)	0	0	1 (14%)	3 (43%)
Soil sampling — grid	25	1 (4%)	0	2 (8%)	5 (20%)	17 (68%)
Soil sampling — management zone	13	0	0	2 (15%)	0	11 (85%)
Remote sensing — aerial photos	6	2 (33%)	0	0	0	4 (67%)
Remote sensing — satellite images	6	2 (33%)	0	0	0	4 (67%)
Soil survey maps	16	4 (25%)	1 (6%)	0	2 (13%)	9 (56%)
Mapping topography, slope, soil depth, etc.	10	4 (40%)	1 (10%)	0	0	5 (50%)
Plant tissue testing	14	2 (14%)	0	2 (14%)	1 (7%)	9 (64%)
On-the-go sensing	6	2 (33%)	0	0	0	4 (67%)
Variable rate nitrogen application	11	1 (9%)	0	2 (18%)	0	8 (73%)
Variable rate phosphorous and potassium application	19	2 (11%)	0	1 (5%)	5 (26%)	11 (58%)
Variable rate lime application	14	2 (14%)	0	0	3 (21%)	9 (64%)
Variable rate seed application	6	3 (50%)	0	0	0	3 (50%)
Variable rate growth regulator application	6	3 (50%)	0	0	0	3 (50%)
Variable rate defoliant application	5	2 (40%)	0	0	0	3 (60%)
Variable rate fungicide application	5	2 (40%)	0	0	0	3 (60%)
Variable rate herbicide application	7	3 (43%)	0	0	0	4 (57%)
Variable rate insecticide application	6	2 (33%)	0	0	0	4 (67%)
Variable rate irrigation	5	2 (40%)	0	0	0	3 (60%)

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 15. Importance of the Extension Service and universities as information sources about precision-farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	26	7 (27%)[3]	3 (12%)	3 (12%)	4 (15%)	9 (35%)
Yield monitoring — without GPS	7	4 (57%)	0	1 (14%)	0	2 (29%)
Yield monitoring — without a yield monitor	6	3 (50%)	0	0	0	3 (50%)
Soil sampling — grid	21	3 (14%)	0	5 (24%)	5 (24%)	8 (38%)
Soil sampling — management zone	13	2 (15%)	0	3 (23%)	3 (23%)	5 (38%)
Remote sensing — aerial photos	6	3 (50%)	0	0	0	3 (50%)
Remote sensing — satellite images	6	3 (50%)	0	0	0	3 (50%)
Soil survey maps	14	3 (21%)	0	2 (14%)	2 (14%)	7 (50%)
Mapping topography, slope, soil depth, etc.	10	3 (30%)	0	0	1 (10%)	6 (60%)
Plant tissue testing	10	3 (30%)	1 (10%)	0	1 (10%)	5 (50%)
On-the-go sensing	7	3 (43%)	0	0	0	4 (57%)
Variable rate nitrogen application	11	5 (45%)	0	1 (9%)	0	5 (45%)
Variable rate phosphorous and potassium application	17	7 (41%)	0	1 (6%)	3 (18%)	6 (35%)
Variable rate lime application	13	6 (46%)	0	0	2 (15%)	5 (38%)
Variable rate seed application	7	3 (43%)	0	0	0	4 (57%)
Variable rate growth regulator application	8	4 (50%)	0	0	0	4 (50%)
Variable rate defoliant application	5	2 (40%)	0	0	0	3 (60%)
Variable rate fungicide application	5	2 (40%)	0	0	0	3 (60%)
Variable rate herbicide application	7	2 (29%)	0	1 (14%)	0	4 (57%)
Variable rate insecticide application	6	2 (33%)	0	0	0	4 (67%)
Variable rate irrigation	5	2 (40%)	0	0	0	3 (60%)

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 16. Importance of other farmers as an information source in learning about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	23	4 (17%)[3]	3 (13%)	6 (26%)	5 (22%)	5 (22%)
Yield monitoring — without GPS	7	2 (29%)	0	1 (14%)	2 (29%)	2 (29%)
Yield monitoring — without a yield monitor	5	3 (60%)	0	1 (20%)	1 (20%)	0
Soil sampling — grid	14	5 (36%)	2 (14%)	3 (21%)	2 (14%)	2 (14%)
Soil sampling — management zone	8	4 (50%)	1 (13%)	3 (38%)	0	0
Remote sensing — aerial photos	4	3 (75%)	0	1 (25%)	0	0
Remote sensing — satellite images	4	3 (75%)	0	1 (25%)	0	0
Soil survey maps	10	6 (60%)	2 (20%)	2 (20%)	0	0
Mapping topography, slope, soil depth, etc.	8	5 (63%)	0	2 (25%)	1 (13%)	0
Plant tissue testing	7	6 (85%)	0	1 (14%)	0	0
On-the-go sensing	4	3 (75%)	0	1 (25%)	0	0
Variable rate nitrogen application	8	6 (75%)	0	1 (13%)	0	1 (13%)
Variable rate phosphorous and potassium application	12	9 (75%)	0	2 (17%)	0	1 (8%)
Variable rate lime application	9	7 (78%)	0	2 (22%)	0	0
Variable rate seed application	4	3 (75%)	0	1 (25%)	0	0
Variable rate growth regulator application	4	2 (50%)	0	1 (25%)	1 (25%)	0
Variable rate defoliant application	3	2 (67%)	0	1 (33%)	0	0
Variable rate fungicide application	3	2 (67%)	0	1 (33%)	0	0
Variable rate herbicide application	4	3 (75%)	0	1 (25%)	0	0
Variable rate insecticide application	3	2 (67%)	0	1 (33%)	0	0
Variable rate irrigation	4	2 (50%)	0	1 (25%)	0	1 (25%)

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 17. Importance of trade shows as an information source about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	20	8 (40%)[3]	1 (5%)	6 (30%)	1 (5%)	4 (20%)
Yield monitoring — without GPS	5	4 (80%)	1 (20%)	0	0	0
Yield monitoring — without a yield monitor	4	3 (75%)	1 (25)	0	0	0
Soil sampling — grid	15	7 (47%)	5 (33%)	1 (7%)	1 (7%)	1 (7%)
Soil sampling — management zone	7	5 (71%)	2 (29%)	0	0	0
Remote sensing — aerial photos	5	3 (60%)	1 (20%)	1 (20%)	0	0
Remote sensing — satellite images	5	3 (60%)	1 (20%)	1 (20%)	0	0
Soil survey maps	9	8 (89%)	1 (11%)	0	0	0
Mapping topography, slope, soil depth, etc.	8	6 (75%)	2 (25%)	0	0	0
Plant tissue testing	7	6 (86%)	1 (14%)	0	0	0
On-the-go sensing	4	3 (75%)	1 (25%)	0	0	0
Variable rate nitrogen application	7	6 (86%)	1 (14%)	0	0	0
Variable rate phosphorous and potassium application	11	9 (82%)	1 (9%)	1 (9%)	0	0
Variable rate lime application	9	7 (78%)	1 (11%)	1 (11%)	0	0
Variable rate seed application	4	3 (75%)	1 (25%)	0	0	0
Variable rate growth regulator application	4	3 (75%)	1 (25%)	0	0	0
Variable rate defoliant application	3	2 (67%)	1 (33%)	0	0	0
Variable rate fungicide application	3	2 (67%)	1 (33%)	0	0	0
Variable rate herbicide application	4	3 (75%)	1 (25%)	0	0	0
Variable rate insecticide application	3	2 (67%)	1 (33%)	0	0	0
Variable rate irrigation	—	—	—	—	—	—

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 18. Importance of the Internet as an information source about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	19	10 (53%)[3]	0	4 (21%)	2 (11%)	3 (16%)
Yield monitoring — without GPS	6	5 (83%)	0	0	0	1 (17%)
Yield monitoring — without a yield monitor	5	4 (80%)	0	0	0	1 (20%)
Soil sampling — grid	15	12 (80%)	1 (7%)	0	0	2 (13%)
Soil sampling — management zone	8	6 (75%)	1 (13%)	0	0	1 (13%)
Remote sensing — aerial photos	5	4 (80%)	0	0	0	1 (20%)
Remote sensing — satellite images	5	4 (80%)	0	0	0	0
Soil survey maps	10	9 (90%)	0	0	0	1 (10%)
Mapping topography, slope, soil depth, etc.	9	8 (89%)	0	0	0	1 (11%)
Plant tissue testing	8	7 (88%)	0	0	0	1 (13%)
On-the-go sensing	5	4 (80%)	0	0	0	1 (20%)
Variable rate nitrogen application	8	7 (88%)	0	0	0	1 (12%)
Variable rate phosphorous and potassium application	12	11 (92%)	0	0	0	1 (8%)
Variable rate lime application	10	9 (90%)	0	0	0	1 (10%)
Variable rate seed application	5	4 (80%)	0	0	0	1 (20%)
Variable rate growth regulator application	5	4 (80%)	0	0	0	1 (20%)
Variable rate defoliant application	4	3 (75%)	0	0	0	1 (25%)
Variable rate fungicide application	4	3 (75%)	0	0	0	1 (25%)
Variable rate herbicide application	5	4 (80%)	0	0	0	1 (20%)
Variable rate insecticide application	4	3 (75%)	0	0	0	1 (25%)
Variable rate irrigation	3	3 (100%)	0	0	0	0

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 19. Importance of the news media as an information source about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Number of responses	Level of importance[2]				
		1	2	3	4	5
Yield monitoring — with GPS	20	12 (60%)[3]	0	2 (10%)	3 (15%)	3 (15%)
Yield monitoring — without GPS	6	5 (83%)	0	1 (17%)	0	0
Yield monitoring — without a yield monitor	4	4 (100%)	0	0	0	0
Soil sampling — grid	14	10 (71%)	0	1 (7%)	2 (14%)	1 (7%)
Soil sampling — management zone	8	7 (88%)	0	1 (13%)	0	0
Remote sensing — aerial photos	4	4 (100%)	0	0	0	0
Remote sensing — satellite images	4	4 (100%)	0	0	0	0
Soil survey maps	9	9 (100%)	0	0	0	0
Mapping topography, slope, soil depth, etc.	8	7 (88%)	1 (13%)	0	0	0
Plant tissue testing	7	7 (100%)	0	0	0	0
On-the-go sensing	4	4 (100%)	0	0	0	0
Variable rate nitrogen application	7	7 (100%)	0	0	0	0
Variable rate phosphorous and potassium application	11	11 (100%)	0	0	0	0
Variable rate lime application	9	9 (100%)	0	0	0	0
Variable rate seed application	4	4 (100%)	0	0	0	0
Variable rate growth regulator application	4	4 (100%)	0	0	0	0
Variable rate defoliant application	3	3 (100%)	0	0	0	0
Variable rate fungicide application	3	3 (100%)	0	0	0	0
Variable rate herbicide application	4	4 (100%)	0	0	0	0
Variable rate insecticide application	3	3 (100%)	0	0	0	0
Variable rate irrigation	3	3 (100%)	0	0	0	0

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 20. Degree of helpfulness assigned to information sources about precision farming technologies reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Source	Average level of helpfulness[2]
Crop consultants	3.62
Extension/universities	3.28
Farm dealers	2.58
Other farmers	1.90
Trade shows	1.38
Internet	1.69
News media	1.13

[1]Survey question 13.
[2]Level of importance ranges from not helpful (1) to very helpful (5).

Table 21. Services used on the farm reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Survey question	Responses	Yes	No
Respondents that use the services of a farmers' cooperative, a technical consultant, a custom applicator, extension service, etc. to perform any precision farming task on the farm.	62	39 (63%)[2]	23 (37%)

[1]Survey question 14.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 22. Management and technical advice usage reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Did you receive advice?		Average cost	Will you purchase this service again?	
	Yes	No	($/A)	Yes	No
Yield monitoring — with GPS	6 (46%)[2]	7 (54%)	5.00	4 (44%)	5 (56%)
Yield monitoring — without GPS	2 (50%)	2 (50%)	0	1 (100%)	0
Yield monitoring — without a yield monitor	2 (40%)	3 (60%)	0	—	—
Soil sampling — grid	14 (88%)	2 (12%)	3.36	11 (92%)	1 (8%)
Soil sampling — management zone	6 (100%)	0	2.60	2 (100%)	0
Remote sensing — aerial photos	1 (100%)	0	0	—	—
Remote sensing — satellite images	0	1 (100%)	—	—	—
Soil survey maps	5 (63%)	3 (38%)	2.67	3 (100%)	0
Mapping topography, slope, soil depth, etc.	3 (50%)	3 (50%)	3.33	3 (100%)	0
Plant tissue testing	4 (57%)	3 (43%)	1.75	2 (100%)	0
On-the-go sensing	0	1 (100%)	—	—	—
Variable rate nitrogen application	3 (60%)	2 (40%)	2.00	1 (100%)	0
Variable rate phosphorous and potassium application	6 (86%)	1 (14%)	0	4 (100%)	0
Variable rate lime application	3 (100%)	0	—	1 (100%)	0
Variable rate seed application	0	1 (100%)	—	—	—
Variable rate growth regulator application	0	1 (100%)	—	—	—
Variable rate defoliant application	1 (50%)	1 (50%)	0	1 (100%)	0
Variable rate fungicide application	0	1 (100%)	—	—	—
Variable rate herbicide application	1 (33%)	2 (67%)	—	—	—
Variable rate insecticide application	0	1 (100%)	—	—	—
Variable rate irrigation	1 (50%)	1 (50%)	—	—	—

[1]Survey question 15.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 23. Custom services hired by responding Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Technology	Did you receive advice?		Average cost	Will you purchase this service again?	
	Yes	No	($/A)	Yes	No
Yield monitoring — with GPS	3 (43%)[2]	4 (57%)	9.00	1 (50%)	1 (50%)
Yield monitoring — without GPS	0	2 (100%)	—	1 (100%)	0
Yield monitoring — without a yield monitor	0	2 (100%)	—	—	—
Soil sampling — grid	17 (89%)	2 (11%)	7.92	15 (88%)	2 (12%)
Soil sampling — management zone	6 (100%)	0	5.80	5 (100%)	0
Remote sensing — aerial photos	—	—	—	—	—
Remote sensing — satellite images	—	—	—	—	—
Soil survey maps	2 (67%)	1 (33%)	7.00	1 (50%)	1 (50%)
Mapping topography, slope, soil depth, etc.	2 (67%)	1 (33%)	3.00	2 (100%)	0
Plant tissue testing	4 (100%)	0	3.00	2 (50%)	2 (50%)
On-the-go sensing	—	—	—	—	—
Variable rate nitrogen application	4 (100%)	0	5.75	1 (33%)	2 (67%)
Variable rate phosphorous and potassium application	13 (100%)	0	7.11	9 (82%)	2 (18%)
Variable rate lime application	8 (100%)	0	6.80	5 (83%)	1 (17%)
Variable rate seed application	1 (100%)	0	4.00	1 (100%)	0
Variable rate growth regulator application	1 (100%)	0	9.00	—	—
Variable rate defoliant application	1 (50%)	1 (50%)	9.00	1 (100%)	0
Variable rate fungicide application	1 (100%)	0	1.00	—	—
Variable rate herbicide application	1 (33%)	2 (67%)	9.00	—	—
Variable rate insecticide application	1 (100%)	0	9.00	—	—
Variable rate irrigation	1 (50%)	1 (50%)	9.00	—	—

[1]Survey question 15.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 24. Results experienced by precision farming adopters on Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Survey question	Responses	Yes	No
Was precision farming profitable on your fields?[1]	43	31 (72%)[2]	12 (28%)
Have you experienced any improvements in environmental quality as a result of precision farming?[3]	42	14 (33%)	28 (67%)

[1]Survey question 16.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.
[3]Survey question 18.

Table 25. Opinions regarding precision farming reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey

	Adopters		Nonadopters	
Do you think it would be profitable for you to use precision farming technologies in the future?[1]	Yes 50 (88%)[2]	No 7 (12%)	Yes 117 (66%)	No 61 (34%)
If you believe it would be profitable, would you prefer to own or rent your equipment?[3]	Own 28 (61%)	Rent 18 (39%)	Own 71 (53%)	Rent 64 (47%)

[1]Survey question 20.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.
[3]Survey question 21.

Table 26. Estimates of the typical purchase price for a cotton yield monitoring system with GPS[1] reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[2]

Estimate a typical purchase price for a cotton yield monitoring system with GPS.	Number of of responses	Average	Standard deviation	Minimum	Maximum
Adopters	22	$8,181.82	$4,622.78	$1,000	$20,000
Nonadopters	78	$7,441.03	$5,623.82	$500	$30,000

[1]Global positioning system.
[2]Survey question 22.

Table 27. Importance of precision farming five years from now reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Item	Number of responses	Level of importance[2]				
		1	2	3	4	5
Cotton						
Adopters	62	1 (2%)[3]	0	20 (32%)	12 (19%)	29 (47%)
Nonadopters	171	13 (8%)	12 (7%)	52 (30%)	59 (35%)	35 (20%)
Corn						
Adopters	38	0	2 (5%)	12 (32%)	13 (34%)	11 (29%)
Nonadopters	119	9 (8%)	13 (11%)	43 (36%)	38 (32%)	16 (13%)
Rice						
Adopters	28	0	1 (4%)	8 (29%)	10 (36%)	9 (32%)
Nonadopters	79	15 (19%)	7 (9%)	29 (37%)	18 (23%)	10 (13%)
Soybeans						
Adopters	50	2 (4%)	9 (18%)	14 (28%)	13 (26%)	12 (24%)
Nonadopters	118	18 (15%)	21 (18%)	43 (36%)	28 (24%)	8 (7%)
Wheat						
Adopters	31	4 (13%)	3 (10%)	9 (29%)	7 (23%)	8 (26%)
Nonadopters	79	23 (29%)	11 (14%)	29 (37%)	13 (16%)	3 (4%)

[1]Survey question 23.
[2]Level of importance ranges from not important (1) to very important (5).
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 28. Cotton equipment as reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Response	Do you own a cotton picker?[1]		Are you considering purchasing/leasing a new cotton picker?[2]	
	Adopters	Nonadopters	Adopters	Nonadopters
Yes	51 (81%)[3]	162 (86%)	15 (25%)	23 (13%)
No	12 (19%)	27 (14%)	46 (75%)	159 (87%)
4-row cotton picker	36 (78%)	118 (87%)	9 (60%)	14 (58%)
5-row cotton picker	6 (13%)	10 (7%)	1 (7%)	2 (8%)
6-row cotton picker	4 (9%)	7 (5%)	5 (33%)	8 (34%)

[1]Survey question 30.
[2]Survey question 32.
[3]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 29. Respondents' willingness to purchase a yield monitor system with a global positioning system for their four- or five-row cotton pickers at a specified dollar amount reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Purchase cost for yield monitor system	Number of responses	Yes	No	Don't know	Don't intend to buy/ lease a new picker
$4,500					
Adopters	6	2 (33%)[2]	2 (33%)	2 (33%)	0
Nonadopters	26	1 (4%)	14 (54%)	8 (31%)	3 (12%)
$6,000					
Adopters	13	3 (23%)	4 (31%)	4 (31%)	2 (15%)
Nonadopters	35	1 (3%)	21 (60%)	7 (20%)	6 (17%)
$7,500					
Adopters	8	0	3 (38%)	3 (38%)	2 (25%)
Nonadopters	26	1 (4%)	12 (46%)	8 (31%)	5 (19%)
$9,000					
Adopters	9	2 (22%)	3 (33%)	3 (33%)	1 (11%)
Nonadopters	31	3 (10%)	16 (52%)	10 (32%)	2 (6%)
$10,500					
Adopters	12	1 (8%)	8 (67%)	3 (25%)	0
Nonadopters	28	0	12 (43%)	8 (29%)	8 (29%)
$12,000					
Adopters	5	0	3 (60%)	1 (20%)	1 (20%)
Nonadopters	20	0	12 (60%)	6 (30%)	2 (10%)

[1]Survey question 31.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 30. Respondents' willingness to purchase a yield monitor system for an additional cost when they purchase or lease a new four- or five-row cotton picker reported by Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Purchase cost for yield monitor system	Number of responses	Yes	No	Don't know	Don't intend to buy/ lease a new picker
$4,500					
Adopters	5	3 (60%)[2]	1 (20%)	1 (20%)	0
Nonadopters	26	1 (4%)	7 (27%)	8 (31)	10 (38%)
$6,000					
Adopters	14	4 (29%)	1 (7%)	5 (36%)	4 (29%)
Nonadopters	34	3 (9%)	12 (35%)	6 (18%)	13 (38%)
$7,500					
Adopters	8	1 (13%)	4 (50%)	3 (38%)	0
Nonadopters	27	1 (4%)	10 (37%)	8 (30%)	8 (30%)
$9,000					
Adopters	10	2 (20%)	3 (30%)	3 (30%)	2 (20%)
Nonadopters	31	3 (10%)	11 (35%)	10 (32%)	7 (23%)
$10,500					
Adopters	12	0	6 (50%)	5 (42%)	1 (8%)
Nonadopters	31	2 (6%)	10 (32%)	9 (29%)	10 (32%)
$12,000					
Adopters	5	0	2 (40%)	2 (40%)	1 (20%)
Nonadopters	18	1 (6%)	9 (50%)	4 (22%)	4 (22%)

[1]Survey question 33.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 31. 2000 farm size and tenure characteristics reported for Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Item	Number of responses	Average	Standard deviation	Minimum	Maximum
Acres owned [1]					
Adopters	39	1,434	2,045	13	12,000
Nonadopters	138	1,045	1,671	10	15,000
Acres share rented [1]					
Adopters	22	1,150	1,518	40	6,000
Nonadopters	67	828	1,097	8	5,500
Typical length of share rental agreement (years) [2]					
Adopters	23	2.6	1.6	0	5
Nonadopters	61	2.7	1.7	0	5
Acres cash rented [2]					
Adopters	50	1,224	1,480	25	8,500
Nonadopters	151	1,053	1,073	17	6,000
Typical length of cash rental agreement (years) [3]					
Adopters	54	3.2	1.3	1	5
Nonadopters	155	2.9	1.5	0	5

[1]Survey question 24.
[2]Survey question 26.
[3]Survey question 25.

Table 32. Planted acres and estimated crop yields for 1999 reported for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Crop	Adopters		Nonadopters	
	Planted acres	Yield	Planted acres	Yield
Cotton				
Average	1,183	803	821	732
Standard deviation	1,494	170	892	219
Minimum	29	400	9	50
Maximum	9,248	1,205	5,500	1,400
Number of responses	60	57	177	173
Corn				
Average	420	145	402	125
Standard deviation	278	27	324	34
Minimum	100	102	12	20
Maximum	1,200	190	1,500	187
Number of responses	22	21	63	62
Soybeans				
Average	1,106	29	737	28
Standard deviation	958	12	711	12
Minimum	60	5	17	8
Maximum	3,550	55	3,500	90
Number of responses	45	44	102	99
Wheat				
Average	235	63	305	51
Standard deviation	157	32	261	17
Minimum	50	37	50	26
Maximum	500	145	1,000	81
Number of responses	10	10	18	19

[1]Survey question 28.

Table 33. Planted acres and estimated crop yields for 2000 reported for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Crop	Adopters		Nonadopters	
	Planted acres	Yield	Planted acres	Yield
Cotton				
Average	1,175	772	889	677
Standard deviation	1,559	208	911	250
Minimum	29	250	10	100
Maximum	10,100	1,120	5,500	1,800
Number of responses	58	55	170	167
Corn				
Average	486	133	418	114
Standard deviation	293	23	311	35
Minimum	45	100	30	30
Maximum	1,200	185	1,400	180
Number of responses	22	21	58	54
Soybeans				
Average	1,073	26	727	22
Standard deviation	936	10	731	11
Minimum	40	5	40	3
Maximum	3,300	50	3,200	46
Number of responses	40	36	98	95
Wheat				
Average	279	74	327	61
Standard deviation	164	29	212	14
Minimum	100	58	55	17
Maximum	574	145	900	80
Number of responses	9	8	22	22

[1]Survey question 28.

Table 34. Annual average spatial yield variability of a typical field reported for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Crop	Least productive third		Average yield		Most productive third	
	Adopters	Nonadopters	Adopters	Nonadopters	Adopters	Nonadopters
Cotton (lb/acre)						
Average	559	543	825	776	1,070	1,000
Standard deviation	162	213	133	202	194	262
Minimum	300	100	500	125	750	150
Maximum	920	1,000	1,120	1,500	1,500	2,000
Number of responses	41	130	43	138	40	128
Corn (bu/acre)						
Average	91	94	132	124	172	156
Standard deviation	33	29	27	25	42	35
Minimum	50	45	80	75	80	95
Maximum	160	200	180	180	250	230
Number of responses	19	50	21	50	20	48
Soybeans (bu/acre)						
Average	19	17	31	28	47	39
Standard deviation	13	11	8	10	14	15
Minimum	5	3	8	5	10	5
Maximum	60	65	50	50	75	70
Number of responses	17	59	29	70	29	67
Wheat (bu/acre)						
Average	43	33	53	53	60	67
Standard deviation	19	13	11	13	24	16
Minimum	10	20	40	40	20	45
Maximum	60	60	70	79	90	100
Number of responses	6	15	5	18	6	15

[1]Survey question 29.

Table 35. Number of Mississippi cotton farmers who own livestock or apply manure to their fields — 2001 Southern Precision Farming Survey.[1]

Item	Responses	Yes	No
Do you own livestock?	248	39 (16%)[2]	209 (84%)
Do you apply manure to your fields?	154	13 (8%)	141 (92%)

[1]Survey question 34.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 36. Average age and number of years farming reported by the primary decision maker for Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Item	Responses	Average years	Minimum years	Maximum years
Age[1]				
All respondents	250	51	21	89
Adopters	63	51	25	78
Nonadopters	187	50	21	89
Years of farming[2]				
All respondents	245	27	3	70
Adopters	62	26	4	57
Nonadopters	183	28	3	70

[1]Survey question 35.
[2]Survey question 36.

Table 37. Education level reported by the primary decision maker for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Item	Did you complete high school?		If yes, how many years did you go to college?		
	Yes	No	Average	Minimum	Maximum
Adopters	57 (90)[2]	6 (10%)	3.7	0	6
Nonadopters	178 (95%)	9 (5%)	2.7	0	7

[1]Survey question 37.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 38. Computer ownership and usage as reported by the primary decision maker for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Item	Adopters		Nonadopters	
	Yes	No	Yes	No
Do you own a computer?	52 (83%)[2]	11 (17%)	150 (80%)	37 (20%)
Do you use it for farm management?	43 (81%)	10 (19%)	92 (58%)	66 (42%)

[1]Survey question 38.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 39. Estimated total household income in 2000 for all respondents from farm and nonfarm sources reported for Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Household income	Is farming your primary source of income?[1]		Total household income[2]	Percentage of household income from farming[3]	
	Yes	No		Responses	Percent
Less than $50,000	41 (73%)[4]	15 (27%)	58 (24%)	57	25
$50,000 to $99,999	73 (88%)	10 (12%)	84 (35%)	82	36
$100,000 to $149,999	36 (92%)	3 (8%)	39 (16%)	38	16
$150,000 to $199,999	11 (79%)	3 (21%)	14 (6%)	13	6
$200,000 to $500,000	25 (89%)	3 (11%)	29 (12%)	27	12
$500,000 or greater	11 (79%)	3 (21%)	15 (6%)	14	6

[1]Survey question 39.
[2]Survey question 41.
[3]Survey question 42.
[4]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 40. Estimated total household income in 2000 for precision farming adopters from farm and nonfarm sources for Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Household income	Is farming your primary source of income?[1]		Total household income[2]	Percentage of household income from farming[3]	
	Yes	No		Responses	Percent
Less than $50,000	5 (56%)[4]	4 (44%)	9 (15%)	9	15
$50,000 to $99,999	22 (96%)	1 (4%)	23 (38%)	23	38
$100,000 to $149,999	7 (78%)	2 (22%)	9 (15%)	9	15
$150,000 to $199,999	5 (83%)	1 (17%)	6 (10%)	6	10
$200,000 to $500,000	8 (100%)	0	8 (13%)	8	13
$500,000 or greater	3 (60%)	2 (40%)	5 (8%)	5	8

[1]Survey question 39.
[2]Survey question 41.
[3]Survey question 42.
[4]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 41. Estimated total household income in 2000 for precision farming nonadopters from farm and nonfarm sources for Mississippi cotton farms — 2001 Southern Precision Farming Survey.

Household income	Is farming your primary source of income? [1]		Total household income [2]	Percentage of household income from farming [3]	
	Yes	No		Responses	Percent
Less than $50,000	36 (77%) [4]	11 (23%)	49 (27%)	48	28
$50,000 to $99,999	51 (85%)	9 (15%)	61 (34%)	59	35
$100,000 to $149,999	29 (97%)	1 (3%)	30 (17%)	29	17
$150,000 to $199,999	6 (75%)	2 (25%)	8 (4%)	7	4
$200,000 to $500,000	17 (85%)	3 (15%)	21 (12%)	19	11
$500,000 or greater	8 (89%)	1 (11%)	10 (6%)	9	5

[1]Survey question 39.
[2]Survey question 41.
[3]Survey question 42.
[4]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 42. Farm planning goals reported by the primary decision maker for Mississippi cotton farms — 2001 Southern Precision Farming Survey.[1]

Item	All	Adopters	Nonadopters
I want to acquire enough farm assets to generate sufficient income for family living.	129 (56%) [2]	35 (57%)	94 (56%)
I want to expand the size of operation through acquiring additional resources.	39 (17%)	14 (23%)	25 (15%)
I am thinking about retirement and transfer of farm to the next generation.	49 (21%)	9 (15%)	40 (24%)
I am considering selling the farm and moving on to a different career.	12 (5%)	3 (5%)	9 (5%)

[1]Survey question 40.
[2]Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

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