Precision Farming by Cotton Producers in Six Southern States: Results from the 2001 Southern Precision Farming Survey

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Executive Summary

Precision farming uses a set of technologies to map yield variability within a farm field and diagnose its causes, prescribe variable rates of inputs across the field according to soil and crop needs, and apply those inputs at variable rates according to the prescription. Cotton farmers lack adequate information to make optimal decisions about the adoption of precision farming technologies. The objectives of this study were 1) to determine attitudes toward and current use of precision farming technologies by cotton producers in the six-state region of Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee and 2) to examine the willingness of cotton producers in the six-state region to pay for a cotton yield monitoring system.

A mail survey of cotton producers in the six-state region was conducted in January and February of 2001. This report presents the aggregate results for the six-state region. Twenty-three percent of respondents had used at least one precision farming technology. The most common technologies used in cotton production were grid and management zone soil sampling, variable rate lime application, plant tissue testing, soil survey maps, and variable rate phosphorous and potassium application. Profit and environmental benefits were the most influential factors in a producer's decision to adopt precision farming technologies, while Extension/University personnel, crop consultants, and farm dealers were the most helpful in learning about these technologies. Eighty-five percent of adopters and 63% of non-adopters thought precision farming would be profitable for them to use in the future. Eighty-six percent of adopters and 74% of non-adopters owned computers, while 74% and 55% used them for farm management, respectively. A farmer's willingness to purchase a cotton yield monitoring system was inversely related to the price of the system.

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Introduction

Production of cotton requires a multitude of inputs and cropping activities that include preparing seed beds, planting, reducing competition from insects and weeds, applying harvest aids, and harvesting cotton. Indeed, the cost of producing cotton is considerably higher than the costs of producing corn, soybeans, or wheat (Gerloff, 2001a and 2001b). Reducing input levels through more efficient input use has been a goal of cotton producers and researchers alike. Precision farming may increase cotton production efficiency, reduce input use, and increase yields and profits.

Precision farming uses a set of technologies 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) summarized the profitability of precision farming. Seventy-three percent of the studies they reviewed found precision farming to be profitable. An important determinant of precision farming profitability is crop value. 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 the Southeast, 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 cotton producers and agribusinesses alike.

The future of precision farming in cotton production depends on how producers view this set of technologies and how willing they are to improve current management practices. Swinton and Lowenberg-DeBoer (1998) caution that the early profits of technology adoption will go 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 the Southeast.

Objectives

The objectives of this study were 1) to determine attitudes toward and current use of precision farming technologies by cotton producers in the six-state region of Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee and 2) to examine the willingness of cotton producers in the six-state region 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. This report provides results aggregated over the six-state region.

A questionnaire was developed to query producers about their attitudes toward and use of precision farming technologies (Appendix I). The questionnaire was pre-tested on two producers in Tennessee, and their suggestions were incorporated into the final version. Following Dillman's (1978) general mail survey procedures, the questionnaire, a postage-paid return envelope, and a cover letter explaining the purpose of the survey were sent to each producer. The initial mailing of the questionnaire was on January 16, 2001, and a reminder post card 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. Recipients were instructed to return a blank questionnaire if they were not a cotton producer.

The list of potential cotton producers, which included a total of 8,411 individuals for the 1999-2000 season, was furnished by the Cotton Board in Memphis, Tennessee (Skorupa, 2000). Of the potential cotton producers, 1,158 were from Alabama, 212 from Florida, 2,990 from Georgia, 1,334 from Mississippi, 1,798 from North Carolina, and 919 from Tennessee. The total number of surveys mailed was reduced to 6,423 by randomly selecting 1,400 potential producers from the Georgia list and 1,400 from the North Carolina list. This reduction lowered the cost of the survey but did not perceptibly reduce the ability to draw inferences about cotton producers in Georgia, North Carolina, or the six-state region.

In estimating means, standard deviations, and percentages for the six-state region, adjustments were made for Georgia and North Carolina to give them proper weight in the sample. For example, because only 1,400 of the 2,990 potential Georgia cotton producers were surveyed, the number of responses was adjusted upward by a factor of 2.14 (or 2,990/1,400) to

give Georgia proper weight in the sample. The adjustment factor for North Carolina was 1.28 (or 1,798/1,400). These adjustments assume that potential cotton producers who were not surveyed would have responded similarly to those who were randomly surveyed from the address lists. The tables in Appendix II report the adjusted number of responses for the six-state region. Means, standard deviations, and percentages reported in those tables are weighted by the adjusted number of responses for each state.

Of the 6,423 questionnaires mailed, 196 were returned undeliverable, and 251 indicated that they were not cotton farmers or they had retired, giving a total of 5,976 cotton producers who received the questionnaire in the six-state region. Making the aforementioned adjustments for Georgia and North Carolina gave an estimated population of cotton producers of 7,885 and estimated responses totaling 1,373, which gave a six-state aggregate response rate of 17% (Appendix II, Table 1).

Definition of Precision Farming

The following statement was given to farmers at the top of the questionnaire (Appendix I): "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." This broad definition of precision farming encompasses technologies that may or may not use Global Positioning Systems (GPS) and Geographical Information Systems (GIS). For example, three categories of yield monitoring were listed; yield monitoring with GPS, yield monitoring without GPS, and yield monitoring without a yield monitor. A farmer using the latter technology was considered to measure within-field yield variability by some method other than yield sensors.

Questions for Adopters (Questions 1-19)

Precision farming technology adopters indicated the number of years they used various precision farming technologies on cotton and other crops (Appendix I). They reported the farm-management value of the technologies they used and the factors that prompted their decisions to practice precision farming. They provided information about soil sampling techniques, use of variable rate input application technologies, and how variable rate application affected total input use and cotton yields. Adopters listed owned or leased precision farming equipment and problems encountered with the equipment. They rated the importance of several information sources in learning about the precision farming technologies they had used or investigated. Off-farm precision farming services used on their farms were identified along with the cost of hiring those services. Adopters indicated whether or not they thought precision farming technologies were profitable on their fields and listed the technologies they planned to discontinue. They also indicated whether or not they had experienced improvements in environmental quality through the use of precision farming, and they identified the improvements observed.

Questions for Adopters and Non-Adopters (Questions 20-41)

Precision farming adopters and non-adopters were questioned about the future of precision farming: Specifically, if they prefer to own or lease equipment; to provide a best estimate of the typical purchase price of a cotton yield monitoring system with GPS (Global Positioning System); and to provide demographic and farm business information. 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 purchase price in the willingness to pay questions. First, respondents were asked if they owned a cotton picker and the size of the picker. Second, they were asked if

they would be willing to purchase a cotton yield monitoring system for their existing cotton picker for the stated price. Third, respondents indicated if they were considering purchasing or leasing a new cotton picker and the size of the picker. Respondents then indicated their willingness to purchase or lease an optional cotton yield monitoring system for the stated price when purchasing or leasing a new cotton picker. The purchase prices for the six groups were $4,500, $6,000, $7,500, $9,000, $10,500, and $12,000. The list price at the time of the survey was $9,500 for a cotton yield monitoring system that included a monitor, a GPS receiver, sensors on two chutes of a 4-5-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 Technology, 2001).

Results

Results are presented in four sections. The first section compares results from the survey with the 1997 Census of Agriculture (US Department of Agriculture, 1999). The second section presents information about the use of precision farming technologies by cotton farmers who have adopted these technologies in the six-state region. In the third section, perceptions about the future of precision farming are presented for all respondents (adopters and non-adopters), along with their willingness to pay for a cotton yield monitoring system. Demographic and farm characteristics are compared for precision farming adopters and non-adopters in the fourth section.

Comparison of Six-State Survey Data with Census Data

The distribution of cotton farmers across the six states in the survey (Appendix II, Table 1) corresponded closely with the 1997 distribution of cotton farmers (US Department of Agriculture, 1999). The distribution of responses across the states was somewhat different from

the distribution of cotton farmers found in the Census and the survey because response rates were different across the states. For example, 22% of total responses were from Georgia (percentage not reported in Appendix II, Table 1) compared with 37% of cotton farmers. The low response rate of 10% for Georgia led to this difference.

Figure 1 shows the age distributions for cotton producers as reported in the 1997 Census compared with the age distribution of farmers who responded to the survey. The majority of respondents (59%) ranged in age from 35 to 54 years, compared with slightly less than a majority (48%) in this category reported in the Census. Respondents who were 34 years of age or less were a smaller percentage of total producers (7%) than were represented in the 1997 Census for this age category (14%). Similarly, respondents who were 65 years of age or older were a smaller percentage of all respondents (11%) than reported in the Census (17%). The largest difference between survey and Census data was for the 45-to-54-age group for which the percentages of farmers in this category were 33% and 25% for the survey and the Census, respectively. Results indicate that survey respondents were concentrated more in the middle age categories than was found in the 1997 Census.

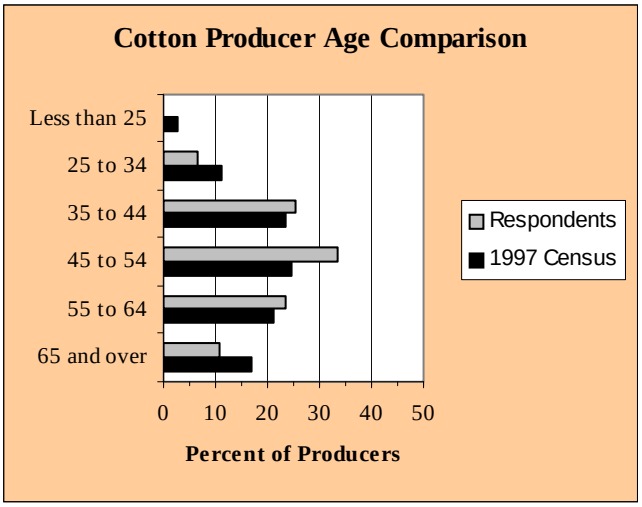

Figure 1. Age distribution of respondents compared with the 1997 Agricultural

Figure 2 compares cotton acres planted per farm in 1999 and 2000 from the survey and from the 1997 Census (US Department of Agriculture, 1999). Results from the survey corresponded closely with the Census data, suggesting that responding cotton producers were representative of cotton farmers in the six-state region when comparing acres of cotton planted per farm.

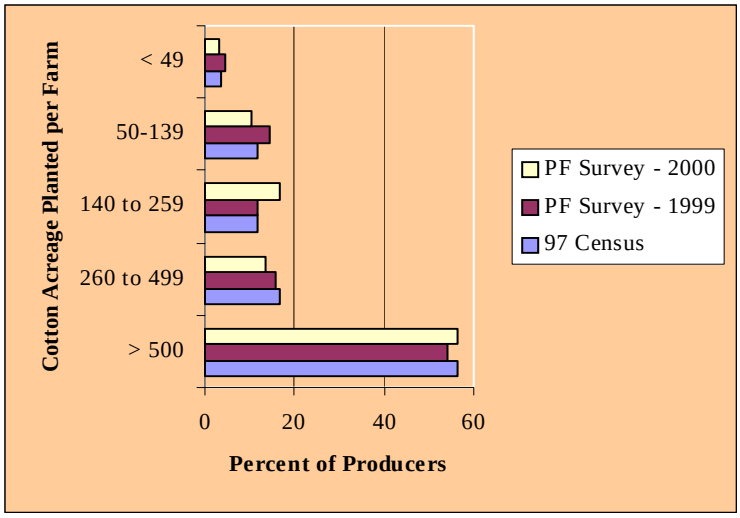

Figure 2. Cotton acres planted per farm for survey respondents compared with the 1997 Agricultural Census

Adopter Responses about Precision Farming

Precision Farming Technology Use

A response to question 1 indicated that a cotton farmer was an adopter of at least one precision farming technology listed. Responses reported in Table 1 indicate that the numbers of precision farming technology adopters by state were 46 of 238 respondents for Alabama (19% of respondents), 7 of 50 respondents for Florida (14%), 75 of 301 respondents for Georgia (25%), 65 of 262 respondents for Mississippi (25%), 94 of 370 respondents for North Carolina (25%), and 29 of 152 respondents for Tennessee (19%). For the six-state region, 23% of respondents were precision farming adopters. Almost all responding adopters had used some form of precision farming technology to produce cotton (293 of 316 adopters), while 163 had used it to produce corn, 124 for peanuts, 39 for rice, 138 for soybeans, 57 for tobacco, and 103 for wheat (not reported in a table).

Adopting producers were asked to indicate the precision farming technologies they had used and the number of years they had used them to produce cotton and other crops (survey question 1). The technologies used for cotton production by the most farmers were grid soil sampling by 158 farmers for an average of 4.2 years, management zone soil sampling by 121 farmers for 10.3 years, variable rate lime application by 116 farmers for 4.8 years, plant tissue testing by 115 farmers for 6.2 years, soil survey maps by 103 farmers for 11.2 years, and variable rate phosphorous and potassium application by 102 farmers for 5.6 years (Appendix II, Table 2). Twenty-eight adopting respondents practiced yield monitoring with GPS for an average of 1.7 years.

Technologies used by the largest numbers of adopters to produce corn were grid soil sampling by 68 farmers for an average of 6.0 years, management zone soil sampling by 68 farmers for 10.7 years, variable rate lime application by 56 farmers for 7.6 years, variable rate phosphorous and potassium application by 55 farmers for 8.1 years, and soil survey maps by 52 farmers for 16.2 years (Appendix II, Table 3). Yield monitoring with GPS and yield monitoring without GPS had 36 and 35 responding farmers using these technologies for 3.0 and 2.8 years, respectively.

The technologies most used for peanut production were grid soil sampling by 52 farmers for an average of 7.5 years, variable rate lime application by 41 farmers for 7.3 years, management zone soil sampling by 40 farmers for 10.7 years, soil survey maps by 39 farmers for 13.0 years, yield monitoring without GPS by 33 farmers for 3.4 years, and variable rate phosphorous and potassium application by 33 farmers for 6.2 years (Appendix II, Table 4). Six adopting respondents practiced yield monitoring with GPS for an average of 1.5 years.

Technologies used by the largest numbers of adopters to produce rice were yield monitoring without GPS by 30 farmers for an average of 2.8 years, management zone soil sampling by 4 farmers for 11.5 years, soil survey maps by 4 farmers for 23.2 years, and yield monitoring with GPS by 3 farmers for 2.3 years (Appendix II, Table 5).

The most used precision farming technologies for soybean production were soil survey maps by 57 farmers for an average of 17.9 years, management zone soil sampling by 49 farmers for 14.7 years, grid soil sampling by 46 farmers for 8.4 years, yield monitoring without a yield monitor by 44 farmers for 17.4 years, and variable rate lime application by 32 farmers for 15.5 years (Appendix II, Table 6). Yield monitoring with GPS was used by 25 adopters on soybeans for an average of 2.8 years, while yield monitoring without GPS was used by 22 adopters for an average of 1.8 years.

Yield monitoring without GPS was used by 20 adopting farmers to produce tobacco for an average of 1.8 years, while soil survey maps were used an average of 20.3 years by 16 farmers. Grid soil sampling, variable rate lime application, and management zone soil sampling were used on tobacco by 14, 14, and 13 adopters for averages of 13.3, 16.2, and 15.7 years, respectively (Appendix II, Table 7). Currently, a yield monitor for tobacco does not exist. Those respondents reporting yield monitoring without GPS probably were in the yield monitoring without a yield monitor category.

Technologies used by the largest numbers of adopters to produce wheat were management zone soil sampling by 39 farmers for 13.4 years, soil survey maps by 38 farmers for 18.3 years, grid soil sampling by 32 farmers for 7.1 years, yield monitoring without a yield monitor by 31 farmers for 17.3 years, and variable rate lime application by 26 farmers for 8.6

years. Yield monitoring with GPS was used by 23 adopters for an average of 2.7 years and yield monitoring without GPS was used by 22 adopters for 1.6 years (Appendix II, Table 8).

With the exception of corn, a larger number of adopting cotton producers used yield monitoring with GPS on cotton than on other crops. The average number of years this technology had been used by adopters on cotton (1.7 years) was lower than for corn (3.0 years), soybeans (2.8 years), and wheat (2.7 years). This finding was not unexpected because accurate yield monitoring technology has only recently become commercially available for cotton production. Grid and management zone soil sampling and soil survey maps were important technologies for adopters on most crops.

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 9 of Appendix II (survey question 2). Average scores given by adopting respondents were highest for "Improving yields" (4.6), "Maintaining better soil test, financial, and yield records," which received average scores of 4.2, 4.1, and 4.1, respectively, and for "Discovering a need for drainage" (3.9). "Quit farming a portion of a field or an entire field" (2.9) and "Discovering a need for leveling" (3.1) were least important to adopters. Nevertheless, with the exception of "Quit farming a portion of a field or an entire field," cotton producers who had adopted precision farming technologies considered these technologies at least moderately important by scoring their value in making management decisions an average of 3.00 or higher.

Factors Influencing Use of Precision Farming Technologies

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 their adoption of precision farming (4.5 average score), with 67% of respondents considering it very important and only 2% indicating it was not important to their decision (Appendix II, Table 10). The fear of being left behind, which had an average score of only 2.4, was least likely to persuade producers to practice precision farming. Environmental benefits received the second highest average score of 3.8, which was considerably lower than the average score received for profit, but still more than moderately important.

Soil Sampling Technologies

Questions 4 through 8 of the survey questioned adopting producers about their soil sampling practices. Forty-five percent of responding adopters did the majority of their soil sampling within management zones, 26% did grid soil sampling, while only 10% pulled cores from grids within management zones (Appendix II, Table 11). Eighteen percent of adopters used none of the precision sampling choices listed in question 4.

Forty-four percent of responding adopters collected their own soil samples (Appendix II, Table 11). Twenty-five percent used a consultant and 31% used a fertilizer or chemical dealer to collect samples. Eighty-four percent of adopters collected cores randomly within a grid or management zone, while only 16% pulled soil cores from around the center point of the grid or management zone.

The average management zone size was 18.8 acres (Appendix II, Table 12). On average, 18.6 soil cores were taken per management zone. The typical grid size for adopters averaged 5.8 acres. On average, 9.6 soil cores were taken per grid.

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 13). Forty-eight percent of responding adopters used variable rate lime application, followed by variable rate phosphorus and potassium application (39%), variable rate growth regulator application (24%), and variable rate nitrogen application (23%). The fewest responding adopter had used variable rate technology for manure application (5%), nematicide application (4%), and irrigation (3%).

For most variable rate input application technologies, more respondents reported decreases in input use than reported increases or no change in input use (Appendix II, Table 13). Of those responding adopters who used variable rate nitrogen application, 47% reported a decrease in nitrogen use, 24% reported and increase, and 29% reported no change in total nitrogen use. Sixty-four percent of responding adopters reported a decrease in total input use with variable rate phosphorus and potassium application. Another 14% reported a decrease in inputs, while 22% saw no affect on total phosphorous and potassium use. Seventy-four percent of responding adopters reported a decrease in total lime use when using variable rate application, with only 11% reporting an increase and 15% reporting no change in lime use. Total growth regulator use also decreased with variable rate application for 75% of responding adopters, while only 7% experienced an increase and another 16% experienced no change in growth regulator use.

Adopters were asked to indicate how their cotton yields changed following variable rate application (survey question 10). Thirty-seven percent of the 210 responding adopters

experienced a 97 lb/acre average increase in cotton lint yield, 9% reported a 166 lb/acre average decrease, and 54% indicated no change in cotton lint yield after variable rate input application (Appendix II, Table 14). Using these percentages of responding adopters to weight the average yield changes gives an estimated perceived lint yield increase of 21 lb/acre (0.37 x 97 lb/acre – 0.09 x 166 lb/acre).

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 price if the equipment was owned, and the lease rate in dollars per acre if it was leased. Adopters were also given an opportunity to list any problems they may have encountered with the equipment. Thirty-one respondents listed a total of 55 pieces of equipment. Among others, listed equipment included Ag Leader cotton and grain yield monitors, Zycon yield monitors, John Deere Greenstar yield monitors, a Terragator 1903 variable rate fertilizer spreader, another unnamed variable rate spreader, Trimble GPS receivers, computers dedicated to precision farming, and computer software.

Average purchase prices are not listed in this publication for several reasons. Respondents did not list the purchase prices for much of the equipment listed. In several cases when the price was listed, the equipment was purchased as an option on new equipment, such as a cotton picker or grain combine, and the total package price was listed. Also, prices are not listed to avoid discloser. Ten producers listed problems with their equipment. Among others, problems encountered by respondents included poor calibration and accuracy for some yield monitors, corrosion for fertilizer spreaders, broken wires, “Getting everything to talk to each other,” and lack of a GPS signal.

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 (4.0), variable rate phosphorous and potassium application (3.9), grid soil sampling (3.8), and variable rate nitrogen application (3.4) (Appendix II, Table 15). Information gathered from farm dealers was not helpful for remote sensing with aerial photography (1.9) and satellite imagery (2.2), mapping topography, slope, soil depth, etc. (2.0), and soil survey maps (2.2).

In Table 16 (Appendix II), results show that crop consultants were most helpful in learning about grid soil sampling (3.9), plant tissue testing (3.7), and variable rate nitrogen (3.7), phosphorus and potassium (3.7), and lime (3.6) applications. They provided the least helpful information in learning about remote sensing with aerial photography (2.5) and satellite imagery (2.9), soil survey maps (2.9), and yield monitoring with (3.0) and without (3.0) GPS.

Adopters considered Extension/universities helpful sources of information in learning about variable rate insecticide application (4.3), management zone soil sampling (4.1), mapping topography, slope, soil depth, etc. (4.1), soil survey maps (4.0), plant tissue testing (4.0), and variable rate defoliant application (4.0), and least helpful in learning about yield monitoring without GPS (3.3), remote sensing with aerial photography (3.6), and variable rate fungicide application (3.6) (Appendix II, Table 17). Without exception, cotton producers who had adopted precision farming technologies considered Extension/universities at least moderately important in learning about these technologies.

Other farmers were not generally rated as helpful sources of information in learning about precision farming technologies. Average scores were highest for yield monitoring with GPS (3.1), yield monitoring without GPS (2.9), and yield monitoring without a yield monitor (2.8) (Appendix II, Table 18). Lowest scores were for remote sensing with aerial photography (1.6) and satellite imagery (1.7), plant tissue testing (1.7), soil survey maps (2.0), and variable rate insecticide application (2.0).

Most adopters indicated that trade shows were not helpful sources of information in learning about precision farming technologies (Appendix II, Table 19). With the exceptions of yield monitoring with GPS (2.7) and yield monitoring without a yield monitor (2.0), all average scores were less than 2.0. Similarly, the Internet and news media were not considered helpful sources of information (Appendix II, Tables 20 and 21). For the Internet, the only average scores above 2.0 were for yield monitoring with GPS (2.2), variable rate insecticide application (2.2), and remote sensing with aerial photography (2.1). For the news media, the only average score above 2.0 was for yield monitoring with GPS (2.7).

Table 22 (Appendix II) summarizes the average scores for learning about all precision farming technologies across all responding adopters. Extension/universities (3.86), crop consultants (3.37), and farm dealers (3.10) were the most helpful sources of information, while the news media (1.68), the Internet (1.75), and trade shows (1.79) were the least helpful in 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 others to

perform any precision farming task. Sixty percent of responding adopters had used off-farm precision farming services (Appendix II, Table 23).

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). Most responding adopters reported receiving management and technical advice concerning two-thirds of the technologies listed in survey question 15 (Appendix II, Table 24). Less than half of respondents reported receiving advice for yield monitoring without GPS, yield monitoring without a yield monitor, remote sensing with satellite imagery, on-the-go sensing, and variable rate seed, fungicide, and irrigation. The largest majority (92%) of responding adopters received advice concerning grid soil sampling. The average cost of advice on grid soil sampling was $3.88/acre and $2.00/acre for management zone soil sampling. Yield monitoring with and without GPS cost $5.44 and $3.50/acre, respectively. Average cost for advice on soil survey maps was $2.50/acre, and for variable rate lime application it was $5.00/acre. Except for remote sensing with aerial photography and variable rate herbicide application, most responding adopters indicated that they would purchase the advice again.

Custom services hired by adopters are presented in Appendix II, Table 25. Grid soil sampling was most popular with 100 of 105 responding adopters who reported hiring this service. Variable rate lime application (44 of 48 responding adopters hiring this service) and variable rate phosphorous and potassium application (41 of 45 hiring the service) were the next most hired precision farming services. Management zone soil sampling (22 of 27), plant tissue testing (21 of 25), and yield monitoring with GPS (15 of 23) were other services hired. Per-acre cost for these services ranged from $8.00/acre for remote sensing using aerial photos to $1.74/acre for plant tissue testing. The average costs of custom hiring services for yield

monitoring with GPS, grid soil sampling, and management zone soil sampling were $4.88, $5.90, $2.21/acre, and for variable rate nitrogen, phosphorus and potassium, and lime they were $4.33, $5.89, and $5.09/acre, respectively. Most responding adopters said they would hire these services 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-five percent of responding adopters thought precision farming was profitable (question 16) on their fields (Appendix II, Table 26). Adopters who found precision farming unprofitable were given an opportunity in question 17 to list the technologies they planned to discontinue. Twenty-one cotton producers responded to this question. Seven respondents said they would discontinue all precision farming; three said they would discontinue grid or management zone soil sampling; two said they would discontinue variable rate input applications; one indicated that satellite imagery would be discontinued; and one indicated that he/she would discontinue hiring services and do the work in-house.

Thirty-eight percent of adopters thought they had experienced an improvement in environmental quality (question 18) as a result of precision farming (Appendix II, Table 26). In question 19, adopters were given an opportunity to list the improvements in environmental quality they had observed. Sixty-five producers answered this question. Responses included, “less nitrogen use”, “less residual nitrogen”, “lower fertilizer rates”, “less fertilizer run-off”, “better drainage”, “leaving out areas that are not profitable”, “better soil texture-tilth”, “more organic matter”, “less spraying”, “water quality”, and “not farming erodible land”.

Adopter and Non-Adopter Responses about Precision Farming

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 the equipment. Eighty-five percent of adopting producers and 63% of non-adopting producers thought precision farming would be profitable for them to use in the future (Appendix II, Table 27). For those respondents who believed it would be profitable, 62% of adopters and 52% of non-adopters would prefer to own the precision farming equipment.

Question 23 gave respondents an opportunity to rate the importance of precision farming for several crops for the next five years. The level of importance ranged from 1 (not important) to 5 (very important). Responding cotton producers rated the importance of precision farming five years in the future the highest for cotton (3.6) and the lowest for tobacco (2.7). All crops except tobacco received an average score of 3.0 or higher. Except for rice, adopters rated the importance of precision farming five years in the future higher than did non-adopters (Appendix II, Table 28). For cotton, the average scores for adopters and non-adopters were 3.9 and 3.5, respectively; for corn they were 3.6 and 3.2; for peanuts they were 3.4 and 3.1; for rice they were 3.0 and 3.2; for soybeans they were 3.1 and 2.9; for tobacco they were 2.8 and 2.7; and for wheat they were 3.2 and 3.0, respectively.

Perceived Price of a Cotton Yield Monitoring System

In question 22, producers were asked to report their best estimates of the typical purchase price for a cotton yield monitoring system with GPS. The average purchase price given by adopters was $8,776, while the average price given by non-adopters was $1,215 less at $7,561

(Appendix II, Table 29). These average prices were less than the list price of $9,500 that prevailed 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 4-5-row picker (Ag Leader technology, 2001).

Willingness to Purchase a Cotton Yield Monitoring System

In question 30, all cotton farmers were asked if they owned a cotton picker, and if they did, they were asked to indicate if they owned a 4, 5, or 6-row picker. The purpose of this question was to determine if the respondent was a candidate for retrofitting a yield monitoring system. Seventy-four percent of adopters and 69% of non-adopters owned a cotton picker (Appendix II, Table 30). Of the adopters who responded to the second part of question 30, 77% owned a four-row cotton picker, 7% owned a five-row picker, and 16% owned a six-row picker. Eighty-nine percent of responding non-adopters owned a four-row picker, 5% owned a five-row picker, 6% owned a six-row picker. Thus, adopters tended to own larger cotton pickers than non-adopters.

Table 31 (Appendix II) reports respondents' willingness to purchase a yield monitoring system for their 4-5-row cotton picker at specified dollar amounts (survey question 31). The percentage of respondents willing to purchase the yield monitoring system was inversely related to the price. For example, as the price increased, the number of respondents willing to purchase the system decreased. The percentages of respondents in the "Don't know" and "Don't own a 4-5-row picker" categories remained about the same as the price increased. Price appears to affect farmers' willingness to purchase a cotton yield monitoring system to retrofit on an existing picker.

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 or leasing an optional yield monitoring system with the new picker. Twenty-five percent of responding adopters and 12% of responding non-adopters were considering purchasing or leasing a new picker (Appendix II, Table 30). Fifty-nine percent, 3%, and 38% of responding adopters were considering purchasing 4-row, 5-row, and 6-row pickers, respectively, while 72%, 3%, and 25% of responding non-adopters were considering these new picker alternatives. Results suggest that adopters tended to favor purchasing or leasing larger cotton pickers than non-adopters.

Table 32 (Appendix II) reports respondents' willingness to purchase or lease an optional yield monitoring system when they purchase or lease a new 4, 5, or 6-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 or lease an optional yield monitoring system as the price increases. An upward trend also exists in the percentage of respondents who were unwilling to purchase or lease the system. These trends are not as pronounced as for the case of retrofitting a yield monitoring system on an existing picker. Nevertheless, the price of a cotton yield monitoring system appears to affect farmers' willingness to pay for the system when purchasing or leasing a new picker.

Respondent and Farm Characteristics for Adopters and Non-Adopters

Farm Characteristics

Respondents were asked to describe their farm in 2000 (questions 24 through 26). On average, precision farming adopters managed 2,297 acres, with 1,063 acres owned, 399 acres share rented under a two-year rental agreement, and 835 acres cash rented under a two-year rental agreement. Compared with adopters, acres managed by non-adopters was lower at 1,337

acres, with 523 acres owned, 239 acres share rented for two years, and 575 acres cash rented for two years (Appendix II, Table 33).

In survey question 27, producers were asked to provide the county where the majority of their farm was located. Results for question 27 are not reported here but are reported in the individual state reports.

Producers reported acres planted and estimated yields for the crops they produced in 1999 and 2000 (survey question 28). On average, adopters planted 1,133 acres of cotton in 1999 with an average lint yield of 790 lb/acre (Appendix II, Table 34). Non-adopters planted 663 acres per farm in 1999, nearly one-half the acres planted by adopters. Cotton lint yield averaged 685 lb/acre for non-adopters, which was 105 lb/acre less than the average yield obtained by adopters. On average, planted cotton acreage and lint yield increased in 2000 for both responding groups (Appendix II, Table 35). Adopters planted 1,175 acres per farm yielding 865 lb/acre, while non-adopters received an average lint yield of 749 lb/acre on 699 acres per farm. Again in 2000, adopters planted about twice as many acres of cotton as non-adopters. Considering crops other than cotton, planted acres were higher for adopters than non-adopters in both years, except for tobacco. Crop yields were also higher for adopters than non-adopters, except for soybean yields in 1999 (Appendix II, Tables 34 and 35).

Producers were asked to provide annual average yields for the most productive one-third, the average, and the least productive one-third of typical crop fields they farmed (question 29). Adopters reported similar or higher yields than non-adopters for all crops in all three yield categories (Appendix II, Table 36). Results suggest that adopters perceived greater yield variability within a typical field for a given crop than non-adopters. For example, the difference between mean yields reported by adopters for the most productive one-third and the least

productive one-third of a typical cotton field was 559 lb/acre (1,148 lb/acre - 589 lb/acre), while this difference was 520 lb/acre (1,053-533 lb/acre) for non-adopters. As another example, for a typical corn field, these yield ranges were 104 bu/acre (191-87 bu/acre) and 79 bu/acre (163-84 bu/acre) for adopters and non-adopters, respectively.

Table 37 (Appendix II) presents producers' responses to survey question 34 concerning livestock. A slightly larger percentage of adopters (37%) than non-adopters (33%) reported owning livestock. Thirty-one percent of adopters and 22% of non-adopters reported applying manure to their fields.

Respondent Characteristics

Producers were queried about their ages, years of farming experience, education, and computer usage (survey questions 35 through 38). The average age (question 35) of a precision farming adopter was 48 years and ranged from 25 to 78 years. Non-adopters averaged 51 years of age, ranging from 21 to 92 years (Appendix II, Table 38). Precision farming adopters had farmed an average of 25 years, while non-adopters had farmed an average of 28 years (survey question 36). Years of farming ranged from three to 63 years for adopters and two to 78 years for non-adopters (Appendix II, Table 38). The overwhelming majority of adopters (97%) and non-adopters (95%) completed high school (question 37). On average, responding adopters had completed more college (three years) than responding non-adopters (two years) (Appendix II, Table 39). The majority of adopters (86%) and non-adopters (74%) owned a computer (question 38) (Appendix II, Table 40). Seventy-four percent of adopters used the computer for farm management, compared with 55% of non-adopters (question 38).

Question 39 asked cotton farmers if farming was their primary source of income (Appendix II, Tables 41, 42, and 43). Farming was the primary source of income for the vast

majority of precision farming adopters (80%) (Appendix II, Table 42), and the same was found for non-adopters, although a slightly smaller percentage of non-adopters depended on farming as their primary source of income (76%) (Appendix II, Table 43). The percentage of responding adopters with farming as their primary source of income was lowest for the $100,000-to-$149,999 category (63%) and highest for the $500,000-or-greater category (90%). The percentage of responding non-adopters with farming as their primary source of income was lowest for the $50,000-to-$99,999 category (71%) and highest for the $500,000-or-greater category (93%).

Precision farming adopters tended to have higher household incomes than non-adopters (survey question 41) (Appendix II, Tables 42 and 43). Fifty-nine percent of responding adopters had total household incomes less than $100,000, while 63% of non-adopters had incomes below $100,000. At the other end of the income scale, 21% of adopters had total household incomes greater than or equal to $200,000, while 16% of non-adopters had incomes in this category.

Survey question 42 asked cotton producers to provide the percentages of their total household incomes from farming. Averaged over all respondents, 69 percent of total household income came from farming (Appendix II, Table 41). Adopters tended to rely more heavily on farm income than non-adopters. Responding adopters reported an average of 72% of their income coming from farming (Appendix II, Table 42), while non-adopters reported 66% of their income coming from farming (Appendix II, Table 43).

Producers indicated the one statement that best described their farm-planning goal. Fifty-three percent of adopters and 52% of non-adopters stated their farm-planning goal was to "acquire enough farm assets to generate sufficient income for family living." Twenty-five percent of adopters wanted to "expand the size of operation through acquiring additional

resources," while 14% of non-adopters had this as their major farm-planning goal. The percentages of adopters and non-adopters who were "thinking about retirement and transfer of farm to the next generation" were 16 and 28%, respectively. Smaller percentages of adopters (5%) and non-adopters (7%) were "considering selling the farm and moving on to a different career."

Conclusions

This report provides information about the use of precision farming technologies by cotton farmers in six southern states. It also provides information about farmers' attitudes toward the use, importance, and profitability of precision farming in the future. Farmers can use this information to help assess technology options and make precision farming technology adoption decisions. Survey results provide insight into several factors that determine whether or not a farmer will adopt precision farming technologies. Some of those factors are discussed below.

Cotton producers who have adopted precision farming technologies tended to have larger scale farming operations. Farming operations for adopters averaged 2,297 acres, compared with 1,337 acres for non-adopters. Larger operations allow fixed investment costs associated with technology adoption to be spread over more acres, reducing per-acre production costs.

Adopters had invested more time in developing human capital through education. A larger percentage of adopters had completed high school (97% versus 95%), and adopters who attended college averaged three years of college compared with two years for non-adopters. The information technologies associated with precision farming are more complex than traditional farming practices. Producers with more education may be more innovative and better able to adjust to new technologies.

The average age of adopters was 48 years, compared with 51 years for non-adopters. Younger farmers have more years before retirement, giving them more incentive to adopt precision farming technologies because they have more years to reap the potential benefits from the investment.

Computers were used for farm management by 74% of adopters and 55% of non-adopters. Producers who own and use a computer for farm management may be more able to process the complex data sets generated by precision faming technologies into useful information for making management decisions.

Tenure arrangements can influence the adoption of new technologies. Adopters owned 46% of the land they farmed, while non-adopters owned 39% of the land they farmed. Farmers who own more of the land they farm may be more likely to adopt new technologies, especially if they perceive that using the new technologies will help them maintain the quality of the land and the environment.

Adopters tended to farm better quality cotton land than non-adopters. Cotton lint yields for adopters averaged 790 lb/acre, compared with 685 lb/acre for non-adopters. Better quality land has higher organic matter content, deeper topsoil, and other qualities that enhance water availability to the crop. Better water availability provides greater potential for yield response to larger amounts of production inputs. Potential cost savings and environmental benefits from more accurate placement of inputs are higher when field average input levels are higher.

Adopters appeared to be more knowledgeable about the cost of precision farming technologies. In the survey, adopters were more accurate in their estimate of the cost of a cotton yield monitoring system. For adopters, the average estimate for the price of a cotton yield monitoring system ($8,776) was only $724 less than the list price at the time of the survey

($9,500), while the average estimate for non-adopters ($7,561) was $1,939 less than the list price.

Attitudes toward the future of precision farming can affect a farmer's willingness to adopt of these technologies. Eighty-five percent of adopters thought precision farming would be profitable for them to use in the future, while 63% of non-adopters thought it would be profitable. When asked about the importance of precision farming during the next five years, adopters rated cotton precision farming 3.9 and non-adopters rated it 3.5 (1 = not important and 5 = very important).

Cotton producers are confronted every day with information concerning the rapidly growing precision farming industry. As more information becomes available, cotton producers will have greater opportunities to make informed decisions about the use of these technologies. Findings from this and other studies that investigate the current use and future prospects for precision farming technologies are important to cotton producers because they provide the needed information for making better decisions about the adoption of these technologies. For example, through this research farmers can discover the precision farming technology options available to them, the extent to which those options have been adopted by their peers, and the attitudes of their peers about the importance and profitability of precision farming in the future.

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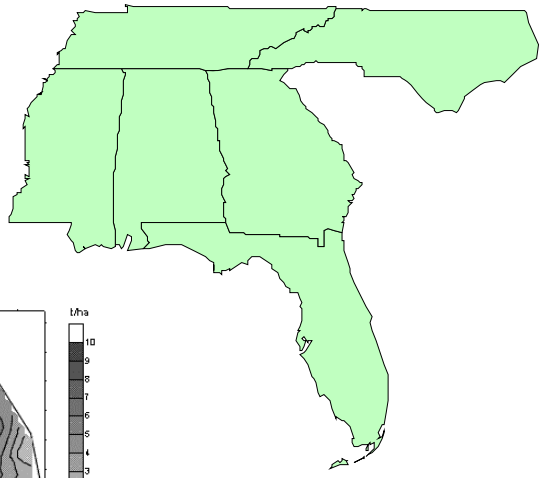
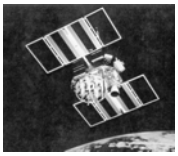
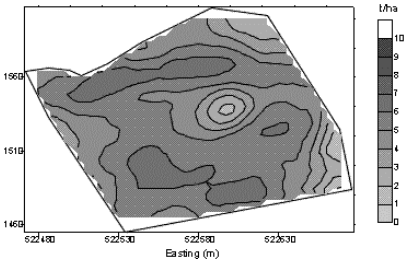
Appendix I: The Questionnaire

2001 Southern Precision Farming Survey







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Sponsored by Cotton Incorporated and the respective Land-Grant Universities

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.				

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?

40. 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. Location of cotton farm businesses, response rates, and precision farming adopters reported by cotton farmers - 2001 Southern Precision Farming Survey

State	1997 Census of Agriculture[a]	1999-2000 Cotton Board Address List	Individuals Surveyed	Cotton Farmers[bc]	Responses[bd]	Precision Farming Adopters[be]
Alabama	1,470 (13%)	1,158	1,158	991 (13%)	238 (24%)	46 (19%)
Florida	343 (3%)	212	212	192 (2%)	50 (26%)	7 (14%)
Georgia	4,188 (37%)	2,990	1,400	2,883 (37%)	301 (10%)	75 (25%)
Mississippi	1,701 (15%)	1,334	1,334	1,282 (16%)	262 (20%)	65 (25%)
North Carolina	2,320 (21%)	1,798	1,400	1,698 (22%)	370 (22%)	94 (25%)
Tennessee	1,156 (10%)	919	919	839 (11%)	152 (18%)	29 (19%)
Six States	11,178	8,511	6,423	7,885	1,373 (17%)	316 (23%)

[a] US Department of Agriculture (1999). Numbers in parentheses indicate the state's percentage of cotton farmers in the six-state region. [b] Numbers for Georgia and North Carolina were adjusted upward by factors of 2.136 = 2,990/1,400 and 1.284 = 1,798/1,400, respectively, to account for farmers on the Cotton Board address list who were not surveyed. This adjustment was required to give Georgia and North Carolina proper weight in forming six-state means and percentages. Numbers in parentheses indicate the state's percentage of cotton farmers in the six-state region. [c] Individuals surveyed on the 1999-2000 Cotton Board address list minus incorrect addresses minus surveys indicating that the respondent was not a cotton farmer. [d] Percentages in parentheses are response rates for surveyed cotton farmers. [e] Numbers in parenthesis indicate the percentage of respondents who had adopted some form of precision farming technology.

Table 2. Years of experience with alternative precision farming technologies for cotton reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS [b]	28	1.7	0.9	1	4
Yield monitoring - without GPS	10	13.0	4.7	3	35
Yield monitoring - without a yield monitor	65	11.4	8.6	1	50
Soil sampling - grid	158	4.2	4.8	1	40
Soil sampling - management zone	121	10.3	7.9	1	40
Remote sensing - aerial photos	21	9.2	5.7	1	30
Remote sensing - satellite images	6	4.4	2.7	1	20
Soil survey maps	103	11.2	6.6	1	40
Mapping topography, slope, soil depth, etc.	18	13.4	9.7	1	25
Plant tissue testing	115	6.2	4.8	1	25
On-the-go sensing	7	4.9	2.4	1	11
Variable rate nitrogen application	64	7.7	5.8	1	40
Variable rate phosphorous and potassium application	102	5.6	5.5	1	40
Variable rate lime application	116	4.8	4.9	1	40
Variable rate seed application	26	9.7	6.0	1	40
Variable rate growth regulator application	76	7.3	4.5	1	35
Variable rate defoliant application	39	8.6	6.3	1	35
Variable rate fungicide application	14	10.8	4.9	1	30
Variable rate herbicide application	43	10.1	6.5	1	40
Variable rate insecticide application	36	9.9	7.8	1	40
Variable rate irrigation	9	11.5	4.3	2	30

[a] Survey question 1. [b] Global positioning system.

Table 3. Years of experience with alternative precision farming technologies for corn reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS[b]	36	3.0	1.4	1	10
Yield monitoring - without GPS	35	2.8	1.7	1	5
Yield monitoring - without a yield monitor	42	16.5	9.7	1	50
Soil sampling - grid	68	6.0	7.7	1	40
Soil sampling - management zone	68	10.7	8.2	1	40
Remote sensing - aerial photos	10	15.3	7.4	1	30
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	52	16.2	8.5	1	35
Mapping topography, slope, soil depth, etc.	10	15.5	2.0	2	25
Plant tissue testing	26	8.6	5.0	1	20
On-the-go sensing	1	-- [c]	--	--	--
Variable rate nitrogen application	26	12.8	8.4	2	40
Variable rate phosphorous and potassium application	55	8.1	7.6	1	40
Variable rate lime application	56	7.6	8.6	1	40
Variable rate seed application	14	18.4	6.5	4	40
Variable rate growth regulator application	5	12.0	3.5	10	20
Variable rate defoliant application	1	--	--	--	--
Variable rate fungicide application	1	--	--	--	--
Variable rate herbicide application	12	21.2	7.7	10	40
Variable rate insecticide application	8	18.7	11.8	10	40
Variable rate irrigation	3	20.0	--	--	--

[a] Survey question 1. [b] Global positioning system. [c] Not reported to avoid disclosure.

Table 4. Years of experience with alternative precision farming technologies for peanuts reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS[b]	6	1.5	0.7	1	2
Yield monitoring - without GPS	33	3.4	1.7	1	5
Yield monitoring - without a yield monitor	20	15.0	9.4	1	50
Soil sampling - grid	52	7.5	9.6	1	40
Soil sampling - management zone	40	10.7	7.0	1	40
Remote sensing - aerial photos	4	14.4	0.0	4	20
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	39	13.0	8.6	2	30
Mapping topography, slope, soil depth, etc.	9	14.2	5.4	2	25
Plant tissue testing	17	11.0	5.1	3	25
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	5	21.3	8.5	10	30
Variable rate phosphorous and potassium application	33	6.2	3.9	1	30
Variable rate lime application	41	7.3	7.6	1	30
Variable rate seed application	6	14.1	4.8	10	25
Variable rate growth regulator application	5	4.0	0.5	3	5
Variable rate defoliant application	1	-- [c]	--	--	--
Variable rate fungicide application	12	6.4	3.4	3	30
Variable rate herbicide application	12	15.9	3.2	3	30
Variable rate insecticide application	10	11.2	7.4	3	30
Variable rate irrigation	3	17.5	--	--	--

[a] Survey question 1. [b] Global positioning system. [c] Not reported to avoid disclosure.

Table 5. Years of experience with alternative precision farming technologies for rice reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS[b]	3	2.3	-- [c]	--	--
Yield monitoring - without GPS	30	2.8	1.8	1	5
Yield monitoring - without a yield monitor	0	0	0	0	0
Soil sampling - grid	1	--	--	--	--
Soil sampling - management zone	4	11.5	8.1	1	20
Remote sensing - aerial photos	0	0	0	0	0
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	4	23.2	1.5	20	25
Mapping topography, slope, soil depth, etc.	1	--	--	--	--
Plant tissue testing	2	10	--	--	--
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	1	--	--	--	--
Variable rate phosphorous and potassium application	1	--	--	--	--
Variable rate lime application	2	15	--	--	--
Variable rate seed application	0	0	0	0	0
Variable rate growth regulator application	1	--	--	--	--
Variable rate defoliant application	1	--	--	--	--
Variable rate fungicide application	0	0	0	0	0
Variable rate herbicide application	1	--	--	--	--
Variable rate insecticide application	1	--	--	--	--
Variable rate irrigation	0	0	0	0	0

[a] Survey question 1. [b] Global positioning system. [c] Not reported to avoid disclosure.

Table 6. Years of experience with alternative precision farming technologies for soybeans reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS[b]	25	2.8	0.7	1	10
Yield monitoring - without GPS	22	1.8	0.9	1	5
Yield monitoring - without a yield monitor	44	17.4	7.5	1	50
Soil sampling - grid	46	8.4	9.1	1	40
Soil sampling - management zone	49	14.7	8.4	1	40
Remote sensing - aerial photos	8	16.2	1.5	10	30
Remote sensing - satellite images	2	1.5	--[c]	--	--
Soil survey maps	57	17.9	6.9	1	40
Mapping topography, slope, soil depth, etc.	11	15.9	6.1	2	25
Plant tissue testing	12	9.1	1.8	2	25
On-the-go sensing	2	7.6	--	--	--
Variable rate nitrogen application	10	18.8	3.9	4	40
Variable rate phosphorous and potassium application	27	15.7	4.3	1	40
Variable rate lime application	32	15.5	5.3	1	40
Variable rate seed application	15	19.0	3.3	4	40
Variable rate growth regulator application	2	12.8	--	--	--
Variable rate defoliant application	2	4.6	--	--	--
Variable rate fungicide application	2	10.4	--	--	--
Variable rate herbicide application	14	23.2	6.6	1	40
Variable rate insecticide application	6	19.0	14.0	3	40
Variable rate irrigation	3	20.0	--	--	--

[a] Survey question 1. [b] Global positioning system. [c] Not reported to avoid disclosure.

Table 7. Years of experience with alternative precision farming technologies for tobacco reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS[b]	1	-- [c]	--	--	--
Yield monitoring - without GPS	20	1.8	1.2	1	5
Yield monitoring - without a yield monitor	8	31.7	11.7	20	50
Soil sampling - grid	14	13.3	14.7	1	40
Soil sampling - management zone	13	15.7	4.3	1	25
Remote sensing - aerial photos	3	20.0	--	--	--
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	16	20.3	2.0	10	30
Mapping topography, slope, soil depth, etc.	5	17.5	5.0	10	20
Plant tissue testing	6	10.0	5.0	5	15
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	10	19.0	13.2	2	40
Variable rate phosphorous and potassium application	12	19.3	12.0	4	40
Variable rate lime application	14	16.2	12.7	3	40
Variable rate seed application	4	23.3	15.3	10	40
Variable rate growth regulator application	3	10.0	--	--	--
Variable rate defoliant application	3	15.0	--	--	--
Variable rate fungicide application	3	15.0	--	--	--
Variable rate herbicide application	6	16.6	9.4	10	40
Variable rate insecticide application	10	21.3	11.3	10	40
Variable rate irrigation	4	20.0	10.0	10	30

[a] Survey question 1. [b] Global positioning system. [c] Not reported to avoid disclosure.

Table 8. Years of experience with alternative precision farming technologies for wheat reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Average	Standard Deviation	Minimum	Maximum
		----------Number of Years----------			
Yield monitoring - with GPS [b]	23	2.7	1.6	1	10
Yield monitoring - without GPS	22	1.6	0.5	1	3
Yield monitoring - without a yield monitor	31	17.3	8.8	1	40
Soil sampling - grid	32	7.1	8.5	1	40
Soil sampling - management zone	39	13.4	9.1	1	40
Remote sensing - aerial photos	6	18.1	2.2	15	30
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	38	18.3	4.7	1	30
Mapping topography, slope, soil depth, etc.	9	18.8	1.3	10	25
Plant tissue testing	14	9.6	2.2	1	20
On-the-go sensing	2	6.3	-- [c]	--	--
Variable rate nitrogen application	12	13.0	6.8	1	40
Variable rate phosphorous and potassium application	22	7.9	6.9	2	40
Variable rate lime application	26	8.6	9.6	1	40
Variable rate seed application	6	17.9	7.3	8	40
Variable rate growth regulator application	2	14.9	--	--	--
Variable rate defoliant application	0	0	0	0	0
Variable rate fungicide application	1	--	--	--	--
Variable rate herbicide application	6	20.9	7.3	8	40
Variable rate insecticide application	3	25.0	--	--	--
Variable rate irrigation	3	20.0	--	--	--

[a] Survey question 1. [b] Global positioning system. [c] Not reported to avoid disclosure.

Table 9. Value of precision farming technologies in management decision making reported by cotton farmers - 2001 Southern Precision Farming Survey[a]

Management Decision	Number of Responses	Level of Importance[b] Not Important----------Very Important					Average Score
		1	2	3	4	5	
Discovering a need for drainage	232	25 (11%)[c]	6 (3%)	32 (14%)	64 (28%)	105 (45%)	3.9
Discovering a need for leveling	218	44 (20%)	26 (12%)	51 (23%)	51 (23%)	46 (21%)	3.1
Discovering a need for improved soil tilth	223	21 (9%)	17 (8%)	52 (23%)	74 (33%)	59 (26%)	3.6
Maintaining a record of field conditions	223	14 (6%)	17 (8%)	64 (29%)	77 (35%)	51 (23%)	3.6
Conducting rental negotiations	219	41 (19%)	15 (7%)	51 (23%)	56 (26%)	56 (26%)	3.3
Deciding on the purchase of crop insurance (or establishing crop insurance units)	226	43 (19%)	20 (9%)	35 (15%)	66 (29%)	62 (27%)	3.4
Maintaining better yield records	240	9 (4%)	8 (3%)	33 (14%)	95 (40%)	95 (40%)	4.1
Maintaining better soil test records	262	3 (1%)	8 (3%)	35 (13%)	102 (39%)	114 (44%)	4.2
Maintaining better financial records	238	12 (5%)	15 (6%)	29 (12%)	62 (26%)	120 (50%)	4.1
Improving yields	273	1 (1%)	9 (3%)	12 (4%)	65 (24%)	186 (68%)	4.6
Reducing N use	245	13 (5%)	15 (6%)	62 (25%)	91 (37%)	64 (26%)	3.7
Reducing P&K use	252	11 (4%)	16 (6%)	68 (27%)	100 (40%)	57 (23%)	3.7
Reducing herbicide use	236	17 (7%)	19 (8%)	62 (26%)	71 (30%)	67 (29%)	3.6
Reducing insecticide use	233	22 (9%)	17 (7%)	53 (23%)	65 (28%)	76 (33%)	3.7
Reducing plant growth regulator use	233	17 (7%)	24 (10%)	69 (30%)	73 (31%)	50 (21%)	3.5
Reducing fungicide use	222	30 (14%)	27 (12%)	62 (28%)	59 (27%)	44 (20%)	3.3
Reducing defoliant use	220	28 (13%)	22 (10%)	65 (30%)	61 (28%)	44 (20%)	3.3
Quit farming a portion of a field or an entire field	215	51 (25%)	31 (14%)	59 (27%)	39 (18%)	35 (16%)	2.9

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

Table 10. Factors that influenced the adoption of precision farming practices reported by cotton farmers - 2001 Southern Precision Farming Survey[a]

Item	Number of Responses	Level of Importance[b] Not Important ……..… Very Important					Average Score
		1	2	3	4	5	
Profit	324	6 (2%) [c]	5 (2%)	15 (4%)	80 (25%)	218 (67%)	4.5
Environmental Benefits	303	12 (4%)	20 (7%)	75 (25%)	112 (37%)	84 (28%)	3.8
Be at the Forefront of Agricultural Technology	296	45 (15%)	41 (14%)	88 (30%)	76 (26%)	47 (16%)	3.1
Fear of Being Left Behind	296	109 (37%)	51 (17%)	69 (23%)	41 (14%)	26 (9%)	2.4

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

Table 11. Soil sampling reported by cotton farmers - 2001 Southern Precision Farming Survey

Item	Number of Responses	Percentage of Responses
How do you do the majority of your soil sampling? [a]		
Management zones	167	45%
Grids	97	26%
Grids within management zones	38	10%
None of the other three choices	68	18%
Who collect the soil samples? [b]		
Self	118	44%
Consultant	68	25%
Fertilizer of chemical dealer	84	31%
How were the cores collected? [c]		
Randomly within a grid or management zone	225	84%
Around the center point of the grid or management zone	44	16%

[a] Survey question 4. [b] Survey question 8. [c] Survey question 7.

Table 12. Average management zone and grid sizes reported by cotton farmers – 2001 Southern Precision Farming Survey

Item	Number of Responses	Average	Standard Deviation	Minimum	Maximum
Average management zone size? (acres) [a]	216	18.8	16.9	1	100
Soil cores taken per management zone [b]	204	18.6	25.1	1	240
Typical grid size (acres) [a]	149	5.8	7.2	1	100
Soil cores taken per grid [b]	115	9.6	12.0	1	200

[a] Survey question 5. [b] Survey question 6.

Table 13. Use of variable rate application technology on cotton fields reported by cotton farmers – 2001 Southern Precision Farming Survey [a]

Input	Did you use variable rate technology to apply?		If you used variable rate technology, how did it affect total input use?			
	Number of Responses	Yes	Number of Responses	Increase[c]	Decrease	Same
N fertilizer	324	74 (23%)[b]	62	24%	47%	29%
P&K fertilizer	322	126 (39%)	109	14%	64%	22%
Lime	337	161 (48%)	133	11%	74%	15%
Manure application	286	14 (5%)	8	38%	38%	25%
Seed	303	32 (11%)	21	24%	48%	33%
Herbicide	306	47 (15%)	35	20%	57%	23%
Insecticide	303	43 (14%)	29	10%	62%	28%
Nematicide	290	10 (4%)	6	17%	33%	50%
Irrigation	285	10 (3%)	7	29%	29%	43%
Fungicide	294	18 (6%)	13	8%	54%	38%
Growth regulator	303	73 (24%)	61	7%	75%	16%
Defoliant	302	46 (15%)	34	32%	41%	26%

[a] Survey question 9. [b] Numbers in parentheses indicate the percentage of respondents who gave the associated answer
[c] The percentage of respondents giving the associated answer.

Table 14. The change in cotton yields following variable rate application reported by cotton farmers - 2001 Southern Precision Farming Survey

	Number of Responses	Increase	Decrease	Same
Following variable rate application, how did your cotton yield change? [a]	210	78 (37%)[b]	18 (9%)	114 (54%)
	Number of Responses	Average	Minimum	Maximum
If your cotton yields changed, by approximately how much did they change? (lb lint/acre)[c]				
Increase in yield	61	97	1	250
Decrease in yield	12	166	33	333

[a] Survey question 10. [b] Numbers in parentheses indicate the percentage of respondents who gave the associated answer.
[c] Survey question 11.

Table 15. Importance of farm dealers as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness[b] Not Helpful ……..…… Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	64	16 (25%) [c]	10 (16%)	6 (10%)	13 (20%)	19 (30%)	3.1
Yield monitoring - without GPS	35	7 (21%)	7 (19%)	2 (7%)	6 (19%)	12 (34%)	3.3
Yield monitoring - without a yield monitor	55	15 (28%)	6 (11%)	7 (13%)	5 (9%)	22 (40%)	3.2
Soil sampling - grid	117	18 (16%)	3 (3%)	12 (10%)	33 (29%)	50 (43%)	3.8
Soil sampling - management zone	55	15 (27%)	5 (10%)	10 (19%)	5 (10%)	19 (35%)	3.2
Remote sensing - aerial photos	25	17 (69%)	1 (5%)	1 (4%)	2 (9%)	3 (13%)	1.9
Remote sensing - satellite images	35	22 (62%)	0 (0%)	4 (10%)	4 (11%)	6 (16%)	2.2
Soil survey maps	48	28 (58%)	3 (7%)	4 (9%)	2 (4%)	10 (21%)	2.2
Mapping topography, slope, soil depth, etc.	39	26 (67%)	1 (3%)	2 (6%)	4 (10%)	6 (15%)	2.0
Plant tissue testing	47	24 (52%)	2 (5%)	5 (12%)	5 (11%)	9 (20%)	2.4
On-the-go sensing	31	17 (54%)	1 (4%)	2 (7%)	3 (8%)	8 (26%)	2.5
Variable rate nitrogen application	53	11 (20%)	6 (12%)	5 (10%)	11 (20%)	20 (37%)	3.4
Variable rate phosphorous and potassium application	95	12 (13%)	6 (6%)	11 (11%)	20 (21%)	47 (49%)	3.9
Variable rate lime application	76	8 (11%)	2 (3%)	10 (13%)	15 (20%)	41 (53%)	4.0
Variable rate seed application	32	11 (34%)	1 (4%)	6 (18%)	4 (12%)	10 (32%)	3.0
Variable rate growth regulator application	30	12 (39%)	3 (9%)	4 (14%)	4 (12%)	8 (26%)	2.8
Variable rate defoliant application	27	11 (40%)	3 (10%)	2 (8%)	4 (13%)	8 (29%)	2.8
Variable rate fungicide application	24	11 (44%)	3 (11%)	1 (5%)	4 (16%)	6 (24%)	2.7
Variable rate herbicide application	27	12 (43%)	3 (10%)	1 (5%)	4 (14%)	8 (29%)	2.8
Variable rate insecticide application	19	12 (64%)	0 (0%)	0 (0%)	2 (12%)	4 (24%)	2.3

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

Table 16. Importance of crop consultants as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness [b] Not Helpful ……..…… Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	59	18 (30%) [c]	7 (11%)	6 (11%)	15 (25%)	13 (23%)	3.0
Yield monitoring - without GPS	37	12 (32%)	2 (6%)	8 (21%)	4 (12%)	10 (29%)	3.0
Yield monitoring - without a yield monitor	49	8 (17%)	5 (10%)	12 (24%)	11 (21%)	14 (28%)	3.3
Soil sampling - grid	103	17 (17%)	4 (4%)	6 (6%)	24 (24%)	51 (49%)	3.9
Soil sampling - management zone	50	12 (24%)	2 (5%)	7 (15%)	4 (9%)	24 (48%)	3.5
Remote sensing - aerial photos	20	10 (51%)	2 (11%)	0 (0%)	2 (11%)	5 (26%)	2.5
Remote sensing - satellite images	34	13 (38%)	2 (7%)	4 (11%)	4 (11%)	11 (32%)	2.9
Soil survey maps	49	20 (40%)	3 (7%)	3 (7%)	7 (15%)	15 (31%)	2.9
Mapping topography, slope, soil depth, etc.	46	11 (23%)	4 (9%)	3 (6%)	9 (19%)	20 (44%)	3.5
Plant tissue testing	50	11 (23%)	1 (2%)	3 (7%)	9 (17%)	26 (52%)	3.7
On-the-go sensing	32	9 (27%)	2 (7%)	3 (8%)	4 (12%)	15 (46%)	3.4
Variable rate nitrogen application	50	8 (15%)	4 (9%)	4 (9%)	12 (24%)	22 (43%)	3.7
Variable rate phosphorous and potassium application	77	12 (15%)	7 (9%)	6 (7%)	21 (27%)	32 (41%)	3.7
Variable rate lime application	63	13 (20%)	5 (7%)	4 (7%)	16 (26%)	25 (40%)	3.6
Variable rate seed application	31	8 (27%)	4 (11%)	1 (4%)	9 (28%)	9 (29%)	3.2
Variable rate growth regulator application	30	8 (28%)	5 (16%)	0 (0%)	9 (30%)	8 (25%)	3.1
Variable rate defoliant application	27	6 (24%)	5 (18%)	0 (0%)	8 (29%)	8 (28%)	3.2
Variable rate fungicide application	25	6 (25%)	4 (14%)	1 (5%)	7 (29%)	7 (27%)	3.2
Variable rate herbicide application	25	7 (30%)	5 (19%)	1 (5%)	3 (10%)	9 (36%)	3.0
Variable rate insecticide application	16	5 (33%)	2 (12%)	0 (0%)	1 (8%)	8 (47%)	3.2

[a] Survey question 13. [b] Level of helpfulness ranges from 1 (not important) to 5 (very important). [c] Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 17. Importance of the Extension Service and universities as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness [b] Not Helpful ……..…… Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	73	9 (13%) [c]	6 (9%)	8 (12%)	16 (22%)	33 (46%)	3.8
Yield monitoring - without GPS	35	7 (19%)	4 (12%)	8 (23%)	4 (12%)	12 (34%)	3.3
Yield monitoring - without a yield monitor	55	4 (7%)	6 (11%)	7 (13%)	12 (22%)	26 (47%)	3.9
Soil sampling - grid	101	5 (5%)	3 (3%)	25 (25%)	26 (26%)	41 (41%)	3.9
Soil sampling - management zone	62	5 (8%)	1 (2%)	8 (12%)	15 (24%)	34 (54%)	4.1
Remote sensing - aerial photos	28	7 (26%)	1 (5%)	1 (5%)	3 (12%)	15 (54%)	3.6
Remote sensing - satellite images	42	7 (17%)	0 (0%)	6 (15%)	7 (18%)	21 (50%)	3.8
Soil survey maps	61	7 (12%)	1 (2%)	8 (12%)	16 (26%)	29 (48%)	4.0
Mapping topography, slope, soil depth, etc.	51	5 (10%)	0 (0%)	7 (14%)	11 (23%)	27 (53%)	4.1
Plant tissue testing	53	5 (9%)	2 (4%)	9 (16%)	12 (22%)	26 (48%)	4.0
On-the-go sensing	31	6 (20%)	1 (4%)	3 (8%)	5 (16%)	16 (52%)	3.7
Variable rate nitrogen application	53	7 (14%)	1 (2%)	8 (16%)	11 (21%)	25 (47%)	3.9
Variable rate phosphorous and potassium application	73	10 (14%)	5 (7%)	13 (18%)	13 (18%)	32 (43%)	3.7
Variable rate lime application	60	10 (17%)	1 (2%)	11 (19%)	14 (24%)	23 (39%)	3.7
Variable rate seed application	35	5 (14%)	1 (4%)	5 (14%)	9 (25%)	15 (43%)	3.8
Variable rate growth regulator application	40	5 (13%)	3 (6%)	4 (11%)	10 (25%)	18 (45%)	3.8
Variable rate defoliant application	31	3 (10%)	3 (8%)	1 (4%)	9 (30%)	15 (47%)	4.0
Variable rate fungicide application	24	3 (13%)	4 (16%)	3 (11%)	4 (15%)	11 (45%)	3.6
Variable rate herbicide application	31	3 (10%)	5 (16%)	4 (12%)	5 (15%)	15 (48%)	3.8
Variable rate insecticide application	23	2 (9%)	1 (4%)	1 (6%)	2 (10%)	16 (71%)	4.3

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

Table 18. Importance of other farmers as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness[b] Not Helpful ……..…… Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	63	13 (20%) [c]	10 (16%)	10 (16%)	19 (30%)	11 (18%)	3.1
Yield monitoring - without GPS	33	11 (34%)	1 (4%)	7 (21%)	6 (19%)	7 (23%)	2.9
Yield monitoring - without a yield monitor	46	13 (29%)	5 (11%)	12 (25%)	8 (17%)	8 (18%)	2.8
Soil sampling - grid	75	26 (35%)	9 (12%)	23 (31%)	7 (10%)	10 (13%)	2.5
Soil sampling - management zone	44	16 (36%)	8 (18%)	9 (21%)	3 (7%)	8 (17%)	2.5
Remote sensing - aerial photos	18	13 (70%)	3 (14%)	1 (5%)	2 (11%)	0 (0%)	1.6
Remote sensing - satellite images	28	19 (69%)	0 (0%)	5 (18%)	4 (13%)	0 (0%)	1.7
Soil survey maps	40	21 (53%)	5 (13%)	9 (21%)	4 (11%)	1 (3%)	2.0
Mapping topography, slope, soil depth, etc.	32	17 (55%)	3 (8%)	6 (19%)	6 (19%)	0 (0%)	2.0
Plant tissue testing	35	25 (72%)	2 (6%)	4 (10%)	2 (6%)	2 (6%)	1.7
On-the-go sensing	28	12 (44%)	4 (14%)	5 (18%)	2 (8%)	4 (16%)	2.4
Variable rate nitrogen application	36	16 (43%)	5 (14%)	7 (19%)	4 (12%)	4 (12%)	2.4
Variable rate phosphorous and potassium application	54	25 (46%)	6 (12%)	11 (21%)	5 (9%)	7 (13%)	2.3
Variable rate lime application	43	23 (52%)	3 (8%)	12 (28%)	3 (8%)	2 (5%)	2.1
Variable rate seed application	28	9 (32%)	5 (17%)	10 (35%)	2 (8%)	2 (8%)	2.4
Variable rate growth regulator application	25	8 (30%)	3 (10%)	10 (40%)	3 (12%)	2 (8%)	2.6
Variable rate defoliant application	22	6 (29%)	6 (29%)	3 (14%)	4 (19%)	2 (9%)	2.5
Variable rate fungicide application	20	8 (39%)	6 (33%)	2 (12%)	2 (12%)	1 (5%)	2.1
Variable rate herbicide application	23	10 (44%)	5 (23%)	4 (16%)	2 (9%)	2 (9%)	2.2
Variable rate insecticide application	11	5 (48%)	3 (24%)	1 (9%)	2 (19%)	0 (0%)	2.0

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

Table 19. Importance of trade shows as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness[b] Not Helpful ..... Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	51	17 (33%) [c]	6 (13%)	11 (22%)	8 (16%)	8 (16%)	2.7
Yield monitoring - without GPS	24	14 (59%)	4 (17%)	5 (19%)	0 (0%)	1 (5%)	1.8
Yield monitoring - without a yield monitor	38	13 (35%)	15 (40%)	7 (18%)	1 (3%)	1 (3%)	2.0
Soil sampling - grid	67	36 (53%)	14 (22%)	9 (13%)	5 (7%)	3 (5%)	1.9
Soil sampling - management zone	32	19 (59%)	9 (27%)	2 (7%)	1 (3%)	1 (3%)	1.6
Remote sensing - aerial photos	20	9 (46%)	7 (33%)	3 (16%)	1 (5%)	0 (0%)	1.8
Remote sensing - satellite images	29	18 (62%)	4 (15%)	5 (16%)	2 (7%)	0 (0%)	1.7
Soil survey maps	37	26 (71%)	4 (11%)	4 (10%)	3 (9%)	0 (0%)	1. 6
Mapping topography, slope, soil depth, etc.	29	21 (73%)	4 (14%)	4 (12%)	0 (0%)	0 (0%)	1.4
Plant tissue testing	34	28 (80%)	3 (9%)	4 (10%)	0 (0%)	0 (0%)	1.3
On-the-go sensing	21	14 (68%)	3 (15%)	4 (17%)	0 (0%)	0 (0%)	1.5
Variable rate nitrogen application	35	22 (65%)	3 (9%)	4 (10%)	4 (13%)	1 (3%)	1.8
Variable rate phosphorous and potassium application	50	33 (66%)	4 (9%)	7 (14%)	3 (7%)	2 (5%)	1.8
Variable rate lime application	37	26 (70%)	4 (12%)	7 (18%)	0 (0%)	0 (0%)	1.5
Variable rate seed application	21	13 (61%)	3 (15%)	5 (23%)	0 (0%)	0 (0%)	1.6
Variable rate growth regulator application	20	12 (61%)	4 (22%)	2 (12%)	1 (5%)	0 (0%)	1.6
Variable rate defoliant application	19	10 (53%)	4 (24%)	3 (18%)	0 (0%)	1 (5%)	1.8
Variable rate fungicide application	15	7 (46%)	6 (38%)	2 (15%)	0 (0%)	0 (0%)	1.7
Variable rate herbicide application	18	9 (50%)	6 (32%)	2 (13%)	0 (0%)	1 (6%)	1.8
Variable rate insecticide application	11	4 (40%)	3 (29%)	3 (31%)	0 (0%)	0 (0%)	1.9

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

Table 20. Importance of the Internet as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness[b] Not Helpful ……..…… Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	44	20 (46%) [c]	3 (8%)	14 (33%)	2 (5%)	4 (9%)	2.2
Yield monitoring - without GPS	23	15 (67%)	1 (4%)	5 (24%)	0 (0%)	1 (4%)	1.7
Yield monitoring - without a yield monitor	36	19 (53%)	6 (16%)	8 (22%)	3 (7%)	1 (3%)	1.9
Soil sampling - grid	58	42 (71%)	7 (12%)	4 (8%)	1 (2%)	4 (7%)	1.6
Soil sampling - management zone	33	20 (61%)	5 (17%)	4 (13%)	0 (0%)	3 (10%)	1.8
Remote sensing - aerial photos	19	9 (49%)	1 (7%)	6 (33%)	1 (5%)	1 (5%)	2.1
Remote sensing - satellite images	27	17 (63%)	0 (0%)	7 (25%)	2 (8%)	1 (4%)	1.9
Soil survey maps	36	26 (73%)	0 (0%)	5 (15%)	3 (9%)	1 (3%)	1.7
Mapping topography, slope, soil depth, etc.	31	24 (75%)	0 (0%)	5 (17%)	0 (0%)	2 (7%)	1.6
Plant tissue testing	34	29 (84%)	0 (0%)	4 (13%)	0 (0%)	1 (3%)	1.4
On-the-go sensing	20	15 (73%)	0 (0%)	4 (22%)	0 (0%)	1 (5%)	1.6
Variable rate nitrogen application	31	22 (73%)	0 (0%)	5 (18%)	1 (3%)	2 (6%)	1.7
Variable rate phosphorous and potassium application	44	34 (77%)	1 (3%)	6 (13%)	1 (2%)	2 (5%)	1.5
Variable rate lime application	35	27 (75%)	0 (0%)	7 (19%)	1 (3%)	1 (3%)	1.6
Variable rate seed application	20	13 (62%)	2 (11%)	4 (22%)	0 (0%)	1 (5%)	1.7
Variable rate growth regulator application	19	13 (67%)	1 (7%)	4 (21%)	0 (0%)	1 (5%)	1.7
Variable rate defoliant application	18	11 (60%)	1 (7%)	4 (22%)	0 (0%)	2 (11%)	2.0
Variable rate fungicide application	15	9 (63%)	1 (9%)	3 (22%)	0 (0%)	1 (7%)	1.8
Variable rate herbicide application	18	11 (63%)	1 (7%)	3 (18%)	0 (0%)	2 (11%)	1.9
Variable rate insecticide application	12	5 (45%)	1 (11%)	4 (35%)	0 (0%)	1 (9%)	2.2

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

Table 21. Importance of the news media as a source of information in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Technology	Number of Responses	Level of Helpfulness[b] Not Helpful ……..……..…… Very Helpful					Average Score
		1	2	3	4	5	
Yield monitoring - with GPS	48	24 (49%) [c]	9 (18%)	7 (15%)	5 (11%)	3 (6%)	2.1
Yield monitoring - without GPS	26	15 (58%)	3 (13%)	5 (20%)	1 (5%)	1 (5%)	1.9
Yield monitoring - without a yield monitor	35	18 (50%)	9 (26%)	4 (10%)	2 (6%)	3 (7%)	2.0
Soil sampling - grid	60	38 (63%)	9 (14%)	6 (11%)	5 (8%)	2 (4%)	1.8
Soil sampling - management zone	34	21 (62%)	3 (8%)	4 (12%)	3 (9%)	3 (9%)	2.0
Remote sensing - aerial photos	23	13 (56%)	3 (15%)	4 (20%)	2 (9%)	0 (0%)	1.8
Remote sensing - satellite images	26	18 (68%)	0 (0%)	5 (18%)	2 (9%)	1 (5%)	1.8
Soil survey maps	33	29 (87%)	1 (3%)	2 (7%)	1 (3%)	0 (0%)	1.3
Mapping topography, slope, soil depth, etc.	29	23 (80%)	2 (8%)	2 (8%)	1 (4%)	0 (0%)	1.4
Plant tissue testing	35	29 (84%)	1 (4%)	2 (7%)	2 (6%)	0 (0%)	1.4
On-the-go sensing	22	17 (78%)	1 (6%)	4 (16%)	0 (0%)	0 (0%)	1.4
Variable rate nitrogen application	32	21 (66%)	1 (4%)	5 (14%)	2 (6%)	3 (10%)	1.9
Variable rate phosphorous and potassium application	46	34 (75%)	4 (8%)	5 (10%)	1 (2%)	2 (5%)	1.6
Variable rate lime application	35	27 (77%)	3 (7%)	6 (16%)	0 (0%)	0 (0%)	1.4
Variable rate seed application	22	16 (72%)	3 (12%)	2 (10%)	0 (0%)	1 (6%)	1.6
Variable rate growth regulator application	18	13 (70%)	3 (14%)	2 (11%)	0 (0%)	1 (5%)	1.6
Variable rate defoliant application	20	11 (54%)	5 (24%)	3 (17%)	0 (0%)	1 (5%)	1.8
Variable rate fungicide application	16	10 (62%)	3 (16%)	2 (14%)	0 (0%)	1 (8%)	1.8
Variable rate herbicide application	18	11 (62%)	3 (14%)	3 (18%)	0 (0%)	1 (6%)	1.7
Variable rate insecticide application	11	6 (60%)	2 (21%)	2 (19%)	0 (0%)	0 (0%)	1.6

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

Table 22. Degree of helpfulness assigned to information sources in learning about precision farming technologies reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Source	Average Level of Helpfulness[b]
Farm Dealers	3.10
Crop Consultants	3.37
Extension/Universities	3.86
Other Farmers	2.38
Trade Shows	1.79
Internet	1.75
News Media	1.68

[a] Survey question 13. [b] Level of helpfulness ranges from 1 (not helpful) to 5 (very helpful).

Table 23. Cotton farmers reporting the use of precision farming services - 2001 Southern Precision Farming Survey

Survey Question	Number of Responses	Yes	No
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? [a]	314	189 (60%)[b]	125 (40%)

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

Table 24. Management and technical advice reported by cotton farmers – 2001 Southern Precision Farming Survey[a]

Technology	Did you receive advice?		Average Cost ($/Acre)	Will you purchase this service again?	
	Yes	No		Yes	No
Yield monitoring – with GPS	27 (62%)[b]	17 (38%)	5.44	2 (100%)	0 (0%)
Yield monitoring – without GPS	3 (29%)	7 (71%)	3.50	6 (100%)	0 (0%)
Yield monitoring – without a yield monitor	7 (47%)	8 (53%)	4.00	7 (77%)	2 (23%)
Soil sampling – grid	72 (92%)	6 (8%)	3.88	4 (100%)	0 (0%)
Soil sampling – management zone	49 (84%)	10 (16%)	2.00	4 (100%)	0 (0%)
Remote sensing – aerial photos	12 (65%)	6 (35%)	4.00	2 (34%)	4 (66%)
Remote sensing – satellite images	4 (37%)	7 (63%)	Nn[c]	11 (92%)	1 (8%)
Soil survey maps	22 (82%)	5 (18%)	2.50	11 (100%)	0 (0%)
Mapping topography, slope, soil depth, etc.	8 (53%)	7 (47%)	3.00	13 (80%)	3 (20%)
Plant tissue testing	35 (83%)	7 (17%)	Nn	13 (93%)	1 (7%)
On-the-go sensing	1 (16%)	5 (84%)	Nn	13 (83%)	3 (17%)
Variable rate nitrogen application	19 (82%)	4 (18%)	Nn	29 (100%)	0 (0%)
Variable rate phosphorous and potassium application	27 (90%)	3 (10%)	Nn	5 (71%)	2 (29%)
Variable rate lime application	24 (88%)	3 (12%)	5.00	12 (91%)	1 (9%)
Variable rate seed application	4 (45%)	5 (55%)	Nn	12 (55%)	10 (45%)
Variable rate growth regulator application	11 (68%)	5 (32%)	Nn	9 (90%)	1 (10%)
Variable rate defoliant application	10 (71%)	4 (29%)	3.00	22 (94%)	1 (6%)
Variable rate fungicide application	4 (50%)	4 (50%)	Nn	18 (85%)	3 (15%)
Variable rate herbicide application	6 (54%)	5 (46%)	Nn	4 (44%)	5 (56%)
Variable rate insecticide application	5 (55%)	4 (45%)	Nn	3 (100%)	0 (0%)
Variable rate irrigation	3 (34%)	6 (66%)	Nn	4 (100%)	0 (0%)

[a] Survey question 15. [b] Numbers in parenthesis indicate the percentage of respondents who gave the associated answer. [c] Nn indicates no response.

Table 25. Custom services hired by responding cotton farmers – 2001 Southern Precision Farming Survey[a]

Technology	Did you hire this service?		Average Cost ($/Acre)	Will you purchase this service again?	
	Yes	No		Yes	No
Yield monitoring – with GPS	15 (64%)[b]	8 (36%)	4.88	11 (78%)	3 (22%)
Yield monitoring – without GPS	0 (0%)	2 (100%)	Nn[c]	1 (100%)	0 (0%)
Yield monitoring – without a yield monitor	1 (39%)	2 (61%)	Nn	1 (100%)	0 (0%)
Soil sampling – grid	100 (95%)	5 (5%)	5.90	72 (82%)	15 (18%)
Soil sampling – management zone	22 (83%)	5 (17%)	2.21	22 (82%)	5 (18%)
Remote sensing – aerial photos	5 (100%)	0 (0%)	8.00	3 (50%)	3 (50%)
Remote sensing – satellite images	3 (76%)	1 (24%)	Nn	2 (50%)	2 (50%)
Soil survey maps	8 (79%)	2 (21%)	5.00	7 (69%)	3 (31%)
Mapping topography, slope, soil depth, etc.	2 (67%)	1 (33%)	3.00	2 (100%)	0 (0%)
Plant tissue testing	21 (84%)	4 (16%)	1.74	16 (83%)	3 (17%)
On-the-go sensing	0 (0%)	0 (0%)	Nn	0 (0%)	0 (0%)
Variable rate nitrogen application	10 (79%)	3 (21%)	4.33	7 (70%)	3 (30%)
Variable rate phosphorous and potassium application	41 (92%)	4 (8%)	5.89	30 (80%)	7 (20%)
Variable rate lime application	44 (93%)	4 (7%)	5.09	30 (79%)	8 (21%)
Variable rate seed application	4 (76%)	1 (24%)	5.00	4 (100%)	0 (0%)
Variable rate growth regulator application	2 (26%)	6 (74%)	5.50	3 (100%)	0 (0%)
Variable rate defoliant application	1 (30%)	2 (70%)	Nn	2 (100%)	0 (0%)
Variable rate fungicide application	1 (30%)	2 (70%)	Nn	1 (100%)	0 (0%)
Variable rate herbicide application	2 (38%)	3 (62%)	7.00	2 (100%)	0 (0%)
Variable rate insecticide application	1 (30%)	2 (70%)	Nn	1 (100%)	0 (0%)
Variable rate irrigation	1 (23%)	3 (77%)	Nn	1 (100%)	0 (0%)

[a] Survey question 15. [b] Numbers in parenthesis indicate the percentage of respondents who gave the associated answer. [c] Nn indicates no response.

Table 26. Perceived profitability of precision farming and environmental benefit experienced by precision farming adopters - 2001 Southern Precision Farming Survey

Survey Question	Number of Responses	Yes	No
Was precision farming profitable on your fields? [a]	242	184 (75%)[b]	57 (25%)
Have you experienced any improvements in environmental quality as a result of precision farming? [c]	246	94 (38%)	152 (62%)

[a] Survey question 16. [b] Numbers in parentheses indicate the percentage of respondents who gave the associated answer. [c] Survey question 18.

Table 27. Opinions about future profitability of precision farming and ownership of precision farming equipment reported by cotton farmers - 2001 Southern Precision Farming Survey

Do you think it would be profitable for you to use precision farming technologies in the future? [a]	All		Adopters		Non-adopters	
	Yes	No	Yes	No	Yes	No
	800 (68%)[b]	368 (32%)	240 (85%)	42 (15%)	560 (63%)	326 (37%)
If you believe it would be profitable, would you prefer to own or rent your equipment? [c]	Own	Rent	Own	Rent	Own	Rent
	486 (55%)	401 (45%)	150 (62%)	91 (37%)	366 (52%)	311 (48%)

[a] Survey question 20. [b] Numbers in parentheses indicate the percentage of respondents who gave the associated answer. [c] Survey question 21.

Table 28. Importance of precision farming five years from now reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Crop	Number of Responses	Level of Importance [b] Not Important ----------Very Important					Average Score
		1	2	3	4	5	
Cotton							
All	1166	89 (8%) [c]	115 (10%)	292 (25%)	366 (31%)	303 (26%)	3.6
Adopters	301	7 (2%)	27 (9%)	63 (21%)	96 (32%)	108 (36%)	3.9
Non-adopters	865	82 (10%)	88 (10%)	229 (26%)	270 (31%)	195 (23%)	3.5
Corn							
All	849	86 (10%)	125 (15%)	229 (27%)	246 (29%)	163 (19%)	3.3
Adopters	220	16 (7%)	27 (12%)	49 (22%)	69 (31%)	60 (27%)	3.6
Non-adopters	629	71 (11%)	98 (16%)	180 (29%)	177 (28%)	103 (16%)	3.2
Peanuts							
All	668	108 (16%)	89 (13%)	176 (26%)	167 (25%)	128 (19%)	3.2
Adopters	162	19 (12%)	22 (14%)	36 (22%)	51 (31%)	34 (21%)	3.4
Non-adopters	506	89 (18%)	67 (13%)	140 (28%)	116 (23%)	94 (19%)	3.1
Rice							
All	666	107 (16%)	89 (13%)	176 (26%)	167 (25%)	128 (19%)	3.2
Adopters	65	16 (25%)	7 (11%)	14 (21%)	16 (25%)	12 (19%)	3.0
Non-adopters	601	90 (15%)	82 (14%)	162 (27%)	150 (25%)	116 (19%)	3.2
Soybeans							
All	779	117 (15%)	163 (21%)	225 (29%)	177 (23%)	97 (12%)	3.0
Adopters	205	28 (13%)	38 (19%)	57 (28%)	52 (25%)	30 (15%)	3.1
Non-adopters	574	89 (16%)	124 (22%)	168 (29%)	125 (22%)	67 (12%)	2.9
Tobacco							
All	460	135 (29%)	67 (15%)	122 (27%)	75 (16%)	60 (13%)	2.7
Adopters	108	29 (27%)	14 (13%)	28 (26%)	24 (22%)	14 (13%)	2.8
Non-adopters	352	106 (30%)	54 (15%)	94 (27%)	52 (15%)	46 (13%)	2.7
Wheat							
All	663	104 (16%)	117 (18%)	200 (30%)	152 (23%)	90 (14%)	3.0
Adopters	172	21 (12%)	37 (21%)	38 (22%)	43 (25%)	33 (19%)	3.2
Non-adopters	491	83 (17%)	81 (16%)	162 (33%)	109 (22%)	57 (12%)	3.0

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

Table 29. Estimates of the typical purchase price for a cotton yield monitoring system with GPS [a] reported by cotton farmers - 2001 Southern Precision Farming Survey[b]

Group	Number of Responses	Average Price	Standard Deviation	Minimum	Maximum
All	338	$7,904	$6,220	$400	$56,000
Adopters	124	$8,776	$5,580	$1,000	$40,000
Non-adopters	314	$7,561	$6,471	$400	$56,000

[a] Global positioning system. [b] Survey question 22.

Table 30. Ownership of cotton pickers and intentions to purchase or lease a new cotton pickers reported by cotton farmers - 2001 Southern Precision Farming Survey

Answer	Do you own a cotton picker?[a]			Are you considering purchasing/leasing a new cotton picker?[b]		
	All	Adopters	Non-adopters	All	Adopters	Non-adopters
Yes	887 (70%) [c]	231 (74%)	656 (69%)	189 (15%)	75 (25%)	114 (12%)
No	382 (30%)	81 (26%)	301 (31%)	1039 (85%)	224 (75%)	815 (88%)
4-row cotton picker	600 (86%)	154 (77%)	446 (89%)	130 (67%)	46 (59%)	84 (72%)
5-row cotton picker	38 (5%)	14 (7%)	24 (5%)	5 (3%)	2 (3%)	3 (3%)
6-row cotton picker	61 (9%)	32 (16%)	29 (6%)	6 0(31%)	30 (38%)	29 (25%)

[a] Survey question 30. [b] Survey question 32. [c] Numbers in parentheses indicate the percentage of respondents who gave the associated answer.

Table 31. Respondents' willingness to purchase a yield monitoring system with GPS for an existing 4 or 5-row cotton picker at a specified dollar amount reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Purchase price for a yield monitoring system for a 4 or 5-row cotton picker	Number of Responses	Yes	No	Don't know	Don't own a 4 or 5-row picker
$4,500					
All	160	16 (10%) [b]	56 (35%)	41 (25%)	47 (30%)
Adopters	38	9 (22%)	10 (26%)	12 (30%)	8 (22%)
Non-adopters	122	7 (6%)	47 (38%)	29 (24%)	39 (32%)
$6,000					
All	203	21 (10%)	89 (44%)	42 (21%)	50 (25%)
Adopters	54	8 (15%)	23 (42%)	12 (22%)	11 (20%)
Non-adopters	149	13 (9%)	67 (45%)	30 (20%)	39 (26%)
$7,500					
All	149	7 (5%)	71 (48%)	31 (21%)	39 (26%)
Adopters	34	5 (16%)	12 (34%)	8 (22%)	9 (28%)
Non-adopters	115	2 (2%)	60 (52%)	24 (21%)	30 (26%)
$9,000					
All	180	14 (8%)	79 (44%)	47 (26%)	41 (23%)
Adopters	38	4 (11%)	14 (38%)	8 (22%)	11 (29%)
Non-adopters	142	10 (7%)	64 (45%)	38 (27%)	30 (21%)
$10,500					
All	154	1 (1%)	86 (56%)	35 (23%)	31 (20%)
Adopters	51	0 (0%)	31 (59%)	7 (14%)	14 (27%)
Non-adopters	102	1 (1%)	56 (54%)	28 (27%)	18 (17%)
$12,000					
All	165	2 (1%)	91 (55%)	29 (18%)	43 (26%)
Adopters	43	1 (2%)	26 (61%)	7 (16%)	9 (20%)
Non-adopters	122	1 (1%)	65 (53%)	22 (18%)	34 (28%)

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

Table 32. Respondents' willingness to purchase or lease an optional yield monitoring system for an additional cost when purchasing or leasing a new 4, 5, or 6-row cotton picker reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Purchase price for a yield monitoring system for a 4 or 5-row cotton picker	Number of Responses	Yes	No	Don't know	Don't intend to purchase or lease a picker
$4,500					
All	167	24 (14%) [b]	38 (23%)	31 (19%)	75 (45%)
Adopters	37	13 (35%)	4 (11%)	8 (23%)	12 (31%)
Non-adopters	130	11 (8%)	34 (26%)	23 (17%)	63 (48%)
$6,000					
All	219	30 (14%)	56 (26%)	48 (22%)	86 (39%)
Adopters	58	15 (26%)	11 (19%)	13 (23%)	18 (32%)
Non-adopters	162	15 (9%)	45 (28%)	34 (21%)	67 (42%)
$7,500					
All	165	9 (5%)	55 (33%)	39 (23%)	63 (38%)
Adopters	35	7 (19%)	13 (36%)	7 (20%)	9 (25%)
Non-adopters	130	2 (2%)	42 (32%)	31 (24%)	54 (42%)
$9,000					
All	203	18 (9%)	61 (30%)	52 (26%)	71 (35%)
Adopters	48	6 (13%)	13 (27%)	10 (21%)	18 (39%)
Non-adopters	155	12 (7%)	49 (31%)	42 (27%)	53 (34%)
$10,500					
All	176	11 (6%)	65 (37%)	47 (26%)	54 (30%)
Adopters	54	2 (4%)	19 (36%)	16 (30%)	16 (30%)
Non-adopters	123	9 (7%)	46 (38%)	30 (25%)	37 (30%)
$12,000					
All	173	7 (4%)	70 (41%)	39 (22%)	57 (33%)
Adopters	50	5 (11%)	14 (27%)	16 (32%)	15 (30%)
Non-adopters	123	2 (1%)	57 (46%)	23 (18%)	42 (34%)

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

Table 33. Year 2000 farm size and tenure characteristics reported by cotton farmers - 2001 Southern Precision Farming Survey

Item	Number of Responses	Average	Standard Deviation	Minimum	Maximum
Acres owned [a]			……. Acres ……		
All	1240	632	1894	0	40000
Adopters	251	1063	2950	0	40000
Non-adopters	990	523	1549	0	20050
Acres share rented [a]					
All	1240	253	643	0	6000
Adopters	251	399	630	0	6000
Non-adopters	990	239	647	0	5500
Acres cash rented [a]					
All	1240	628	806	0	8500
Adopters	251	835	1030	0	8500
Non-adopters	990	575	731	0	6000
Typical length of share rental agreement [b]		..…….. Years ……			
All	399	2	2	1	20
Adopters	99	2	2	1	20
Non-adopters	301	2	2	1	20
Typical length of cash rental agreement (years) [c]					
All	1009	2	2	1	20
Adopters	252	2	2	1	20
Non-adopters	757	2	2	1	20

[a] Survey question 24. [b] Survey question 26. [c] Survey question 25.

Table 34. Planted acres and estimated crop yields for 1999 reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Crop		All		Adopters		Non-Adopters	
		Acreage	Yield	Acreage	Yield	Acreage	Yield
Cotton	Responses	1182	1155	284	277	898	878
		Acres	**lb/ac**	**Acres**	**lb/ac**	**Acres**	**lb/ac**
	Average	776	711	1133	790	663	685
	St. Dev.	933	224	1271	214	826	226
	Minimum	8	50	25	50	8	50
	Maximum	9248	1400	9248	1285	7000	1400
Corn	Responses	496	482	135	132	361	350
		Acres	**bu/ac**	**Acres**	**bu/ac**	**Acres**	**bu/ac**
	Average	345	129	519	140	289	125
	St. Dev.	779	38	1245	41	632	38
	Minimum	5	20	15	25	5	20
	Maximum	18000	220	18000	220	1800	200
Peanuts	Responses	422	407	107	106	314	301
		Acres	**lb/ac**	**Acres**	**lb/ac**	**Acres**	**lb/ac**
	Average	234	3310	329	3897	203	3124
	St. Dev.	278	906	302	825	270	932
	Minimum	3	800	18	1500	3	800
	Maximum	5000	5000	2100	4920	5000	5000
Rice	Responses	24	23	8	8	16	15
		Acres	**cwt/ac**	**Acres**	**cwt/ac**	**Acres**	**cwt/ac**
	Average	503	68	604	76	471	66
	St. Dev.	267	25	257	35	270	22
	Minimum	75	37	300	37	75	46
	Maximum	1100	140	934	140	1100	118
Soybeans	Responses	561	536	154	147	407	390
		Acres	**bu/ac**	**Acres**	**bu/ac**	**Acres**	**bu/ac**
	Average	525	27	706	27	467	27
	St. Dev.	795	11	1147	11	683	10
	Minimum	1	3	1	5	5	3
	Maximum	12000	90	12000	65	3500	90
Tobacco	Responses	191	189	39	40	152	148
		Acres	**lb/ac**	**Acres**	**lb/ac**	**Acres**	**lb/ac**
	Average	61	2370	59	2466	61	2340
	St. Dev.	80	471	55	515	88	457
	Minimum	1	1200	12	1200	1	1450
	Maximum	600	4500	265	4500	600	3600
Wheat	Responses	268	262	82	82	186	180
		Acres	**bu/ac**	**Acres**	**bu/ac**	**Acres**	**bu/ac**
	Average	264	59	286	60	257	59
	St. Dev.	266	17	229	17	278	17
	Minimum	10	20	10	20	10	20
	Maximum	2000	145	700	145	2000	90

[a] Survey question 28.

Table 35. Planted acres and estimated crop yields for 2000 reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Crop		All		Adopters		Non-Adopters	
		Acreage	Yield	Acreage	Yield	Acreage	Yield
Cotton	Responses	1156	1120	282	276	874	843
		Acres	**lb/ac**	**Acres**	**lb/ac**	**Acres**	**lb/ac**
	Average Yield	815	777	1175	865	699	749
	St. Dev.	935	223	1266	218	828	225
	Minimum	8	18	15	18	8	100
	Maximum	10100	1800	10100	1170	7300	1800
Corn	Responses	528	483	148	143	381	340
		Acres	**bu/ac**	**Acres**	**bu/ac**	**Acres**	**bu/ac**
	Average Yield	336	126	501	140	282	121
	St. Dev.	756	48	1204	47	611	48
	Minimum	7	7	10	15	7	7
	Maximum	18000	240	18000	240	2000	228
Peanuts	Responses	435	424	108	107	327	318
		Acres	**lb/ac**	**Acres**	**lb/ac**	**Acres**	**lb/ac**
	Average Yield	261	3384	358	4027	229	3173
	St. Dev.	412	1013	308	1027	445	1009
	Minimum	3	294	12	500	3	294
	Maximum	4300	5600	2400	5600	4300	5174
Rice	Responses	22	20	8	8	14	12
		Acres	**cwt/ac**	**Acres**	**cwt/ac**	**Acres**	**cwt/ac**
	Average Yield	455	67	470	79	451	63
	St. Dev.	420	27	334	37	448	24
	Minimum	25	38	25	45	75	38
	Maximum	2000	155	1000	155	2000	95
Soybeans	Responses	538	522	148	143	407	390
		Acres	**bu/ac**	**Acres**	**bu/ac**	**Acres**	**bu/ac**
	Average Yield	522	29	704	30	467	27
	St. Dev.	794	10	1151	9	683	10
	Minimum	1	2	1	2	5	3
	Maximum	12000	67	12000	55	3500	90
Tobacco	Responses	190	190	39	39	151	151
		Acres	**lb/ac**	**Acres**	**lb/ac**	**Acres**	**lb/ac**
	Average Yield	56	2574	54	2693	57	2535
	St. Dev.	73	460	51	557	80	428
	Minimum	1	300	10	300	1	1000
	Maximum	500	3700	255	3700	500	3600
Wheat	Responses	280	274	89	87	192	188
		Acres	**bu/ac**	**Acres**	**bu/ac**	**Acres**	**bu/ac**
	Average Yield	255	68	288	70	245	67
	St. Dev.	247	17	262	18	243	16
	Minimum	10	17	10	30	10	0
	Maximum	1500	145	900	145	100	0

[a] Survey question 28.

Table 36. Annual average spatial yield variability for a typical field reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Crop		Least Productive Third			Average Yield			Most Productive Third		
		All	Adopters	Non-adopters	All	Adopters	Non-adopters	All	Adopters	Non-adopters
Cotton	Responses	833	217	616	874	224	650	829	216	613
						Pounds/acre				
	Average Yield	548	589	533	821	870	804	1078	1148	1053
	Standard Dev.	194	176	200	173	153	180	246	210	259
	Minimum	50	50	50	125	200	125	100	100	100
	Maximum	1200	950	1200	1500	1168	1500	2000	1500	2000
Corn	Responses	400	125	275	406	129	277	397	129	267
						Bushels/acre				
	Average Yield	85	87	84	130	142	124	173	191	163
	Standard Dev.	33	33	34	33	37	31	44	51	40
	Minimum	10	15	10	25	40	25	35	40	35
	Maximum	200	175	200	240	240	200	300	240	260
Peanuts	Responses	267	78	189	284	85	199	268	78	190
						Pounds/acre				
	Average Yield	2624	2908	2508	3550	3967	3371	4462	4839	4307
	Standard Dev.	928	949	919	827	859	813	915	870	934
	Minimum	125	250	125	500	500	700	600	600	950
	Maximum	4700	4000	4700	5600	5600	4900	6500	6500	6000
Rice	Responses	14	4	10	14	4	10	14	4	10
						Cwt/acre				
	Average Yield	75	84	71	90	104	85	104	121	97
	Standard Dev.	36	32	37	42	47	40	50	66	44
	Minimum	20	60	20	40	62	40	54	65	54
	Maximum	130	130	130	160	160	145	200	200	160
Soybeans	Responses	394	109	285	408	114	294	396	112	284
						Bushels/acre				
	Average Yield	19	21	19	33	34	32	47	49	46
	Standard Dev.	9	10	9	8	8	9	12	11	12
	Minimum	3	5	3	5	8	5	5	10	5
	Maximum	65	60	65	60	55	60	80	80	75
Tobacco	Responses	124	29	95	131	31	100	124	26	98
						Pounds/acre				
	Average Yield	1956	1990	1946	2484	2553	2463	2917	2944	2910
	Standard Dev.	456	382	478	326	286	339	398	369	405
	Minimum	400	1500	400	1750	2000	1750	2200	2500	2200
	Maximum	3000	2700	3000	3200	3200	3200	4000	3600	4000
Wheat	Responses	207	63	144	211	64	147	209	64	145
						Bushels/acre				
	Average Yield	39	40	39	59	62	58	80	85	77
	Standard Dev.	12	14	12	12	13	12	18	20	17
	Minimum	10	10	10	20	25	20	20	20	30
	Maximum	70	65	70	80	80	79	115	115	110

[a] Survey question 29.

Table 37. Number of cotton farmers who own livestock or apply manure to their fields - 2001 Southern Precision Farming Survey [a]

Item	Number of Respondents	Yes	No
Do you own livestock?			
All	1255	421 (34%)[b]	834 (66%)
Adopters	305	112 (37%)	193 (63%)
Non-adopters	950	309 (33%)	641 (66%)
Do you apply manure to your fields?			
All	704	212 (24%)	674 (76%)
Adopters	170	67 (31%)	151 (69%)
Non-adopters	534	145 (22%)	524 (78%)

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

Table 38. Average age and years of experience farming reported by cotton farmers – 2001 Southern Precision Farming Survey

Item	Number of Responses	Average	Minimum	Maximum
		----------Number of Years----------		
Age? [a]				
All	1262	50	21	92
Adopters	312	48	25	78
Non-adopters	950	51	21	92
Number of years of farming? [b]				
All	1209	27	2	78
Adopters	302	25	3	63
Non-adopters	907	28	2	78

[a] Survey question 35. [b] Survey question 36.

Table 39. Education level reported by cotton farmers - 2001 Southern Precision Farming Survey[a]

Item	Did you complete high school?		If yes, how many years did go to college?			
	Yes	No	Number of Responses	Average	Minimum	Maximum
All	1198 (95%) [b]	59 (5%)	783	2	0	8
Adopters	302 (97%)	10 (3%)	280	3	0	8
Non-Adopters	896 (95%)	49 (5%)	503	2	0	8

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

Table 40. Computer ownership and usage as reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Item	All		Adopters		Non-Adopters	
	Yes	No	Yes	No	Yes	No
Do you own a computer	967 (77%) [b]	284 (23%)	269 (86%)	44 (14%)	698 (74%)	240 (26%)
Do you use it for farm management	625 (60%)	412 (40%)	207 (74%)	73 (26%)	419 (55%)	339 (45%)

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

Table 41. Estimated total household income in 2000 for all respondents from farm and non-farm sources reported by cotton farmers - 2001 Southern Precision Farming Survey

Household Income	Is farming your primary source of income? [a]		Total Household Income [b]	Percentage of Household Income From Farming [c]	
	Yes	No		Number of Responses	Average Percent
Less than $50,000	274 (80%) [d]	67 (20%)	340 (29%) [e]	310	69%
$50,000 to $99,999	308 (74%)	108 (26%)	417 (35%)	409	63%
$100,000 to $149,999	123 (72%)	48 (28%)	170 (14%)	172	66%
$150,000 to $199,999	44 (75%)	15 (25%)	59 (5%)	58	71%
$200,000 to $500,000	100 (87%)	16 (13%)	115 (10%)	113	74%
$500,000 or greater	84 (92%)	7 (8%)	91 (8%)	90	89%
All Respondents	933 (78%)	261 (22%)		1152	69%

[a] Survey question 39. [b] Survey question 41. [c] Survey question 42. [d] Numbers in parentheses indicate the percentage of respondents who gave the associated answer. [e] Numbers in parentheses indicate the percentage of respondents in the corresponding income category.

Table 42. Estimated total household income in 2000 for responding adopters from farm and non-farm sources reported by cotton farmers - 2001 Southern Precision Farming Survey

Household Income	Is farming your primary source of income? [a]		Total Household Income [b]	Percentage of Household Income From Farming [c]	
	Yes	No		Number of Responses	Average Percent
Less than $50,000	55 (79%) [d]	14 (21%)	69 (23%) [e]	65	72%
$50,000 to $99,999	91 (83%)	19 (17%)	110 (36%)	99	73%
$100,000 to $149,999	31 (63%)	18 (37%)	50 (16%)	48	62%
$150,000 to $199,999	8 (72%)	3 (28%)	12 (4%)	10	67%
$200,000 to $500,000	30 (87%)	4 (13%)	35 (11%)	34	78%
$500,000 or greater	27 (90%)	3 (10%)	30 (10%)	29	84%
All Responding Adopters	242 (80%)	61 (20%)		285	72%

[a] Survey question 39. [b] Survey question 41. [c] Survey question 42. [d] Numbers in parentheses indicate the percentage of respondents who gave the associated answer. [e] Numbers in parentheses indicate the percentage of respondents in the corresponding income category.

Table 43. Estimated total household income in 2000 for responding non-adopters from farm and non-farm sources reported by cotton farmers - 2001 Southern Precision Farming Survey

Household Income	Is farming your primary source of income? [a]		Total Household Income [b]	Percentage of Household Income From Farming [c]	
	Yes	No		Number of Responses	Average Percent
Less than $50,000	185 (76%) [d]	58 (24%)	242 (28%) [e]	203	69%
$50,000 to $99,999	217 (71%)	87 (29%)	305 (35%)	247	56%
$100,000 to $149,999	91 (74%)	31 (26%)	122 (14%)	103	64%
$150,000 to $199,999	36 (75%)	12 (25%)	48 (6%)	37	73%
$200,000 to $500,000	70 (85%)	12 (15%)	82 (9%)	58	75%
$500,000 or greater	56 (93%)	4 (7%)	61 (7%)	51	90%
All Responding Non-adopters	655 (76%)	204 (24%)		699	66%

[a] Survey question 39. [b] Survey question 41. [c] Survey question 42. [d] Numbers in parentheses indicate the percentage of respondents who gave the associated answer. [e] Numbers in parentheses indicate the percentage of respondents in the corresponding income category.

Table 44. Farm planning goals reported by cotton farmers - 2001 Southern Precision Farming Survey [a]

Item	All	Adopters	Non-adopters
I want to acquire enough farm assets to generate sufficient income for family living.	612 (52%) [b]	152 (53%)	460 (52%)
I want to expand the size of operation through acquiring additional resources.	196 (17%)	70 (25%)	127 (14%)
I am thinking about retirement and transfer of farm to the next generation.	288 (25%)	47 (16%)	240 (28%)
I am considering selling the farm and moving on to a different career.	73 (6%)	17 (5%)	56 (7%)

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