Institute of Agriculture
Department of Agricultural Economics

Research Series 08-01
January 2002

Precision Farming by Tennessee Cotton Producers: Results from the 2001 Southern Precision Farming Survey

Rebecca L. Cochran, Roland K. Roberts,
Burton C. English
and James A. Larson

Department of Agricultural Economics
The University of Tennessee
Knoxville

Precision Farming by Tennessee Cotton Producers: Results from the 2001 Southern Precision Farming Survey

Rebecca L. Cochran, Roland K. Roberts, Burton C. English

and James A. Larson

Research Series 08-01

Department of Agricultural Economics
The University of Tennessee
Knoxville, Tennessee

Rebecca L. Cochran is a Research Associate, Roland K. Roberts and Burton C. English are Professors, and James A. Larson is an Associate Professor.

Please visit the department's web site at http://economics.ag.utk.edu.

Additional copies of this report may be obtained from:

Department of Agricultural Economics
The University of Tennessee
2621 Morgan Circle
Knoxville, TN 37796-4518
(865) 974-7231

Acknowledgements

Support for this research was provided by Cotton Incorporated and the University of Tennessee Agricultural Experiment Station. Cover art was provided by Tina Johnson, Assistant in Agricultural Extension.

Disclaimer

Mention of trade names or other proprietary marks does not imply approval of products to the exclusion of similar products nor does it constitute endorsement by the authors, Cotton Incorporated, or the Tennessee Agriculture Experiment Station.

E11-1215-00-007-02

TABLE OF CONTENTS

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. Currently, Tennessee cotton farmers lack adequate information to make optimal decisions about the adoption of precision farming technologies on their fields. The objectives of this study were 1) to determine attitudes toward and current use of precision farming technologies by Tennessee cotton producers and 2) to examine Tennessee cotton producers' willingness to pay for a cotton yield monitoring system. A mail survey of cotton producers in Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee was conducted in January and February of 2001. This report presents the Tennessee results from that survey. Twenty-nine respondents (19% of respondents) had used at least one precision farming technology. The most common technologies used in cotton production were grid soil sampling, soil survey maps, variable rate growth regulator application, and variable rate nitrogen application. Profit and environmental benefits were the most influential factors in a producer's decision to adopt precision farming technologies, while farm dealers and Extension/University personnel were the most helpful in learning about these technologies. Eighty-five percent of adopters and 64% of non-adopters thought precision farming would be profitable for them to use in the future. Eighty-three percent of adopters and 72% of non-adopters owned computers, while 75% and 55% used them for farm management, respectively. Farmer's willingness to purchase a cotton yield monitoring system was inversely related to the price of the system. Findings from this study are important to cotton producers in making better decisions regarding adoption of precision farming technologies.

Precision Farming by Tennessee Cotton Producers:

Results from the 2001 Southern Precision Farming Survey

Rebecca L. Cochran, Roland K. Roberts, Burton C. English, and James A. Larson

Introduction

Preparing seed beds, planting, reducing competition from insects and weeds, applying harvest aids, and harvesting cotton require numerous trips across a field and the purchase of a multitude of inputs. The Tennessee Agricultural Extension Service estimates the cost of machinery and variable inputs at $323.43/acre for conventional cotton (Gerloff, 2001A). Indeed, cotton uses more than twice as many inputs than conventional corn ($156.21/acre), soybeans ($108.94/acre), and wheat ($122.31/acre) (Gerloff, 2001B). Reducing input levels through more efficient input use has long 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 is being hailed as a set of new technologies promising private economic gains and societal environmental benefits. These new technologies are used to identify and measure within-field variability and its causes, prescribe site-specific input applications that match varying crop and soil needs, and apply the inputs as prescribed. Thus far, most producers have made only modest investments in precision farming technologies (Lowenberg-DeBoer, 1999).

A review of literature by Lambert and Lowenberg-DeBoer (2000) summarized the profitability of precision farming. Seventy-three percent of the studies they reviewed found precision farming to be profitable. Early studies that investigated the economic potential of

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

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 Tennessee, 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

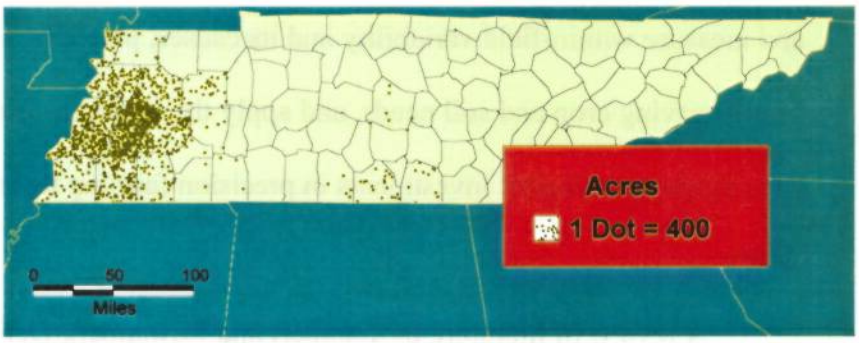


Figure 1. Acres planted in cotton, Tennessee, 2000

newly developed yield monitoring systems would provide important information for Tennessee cotton producers and agribusinesses alike.

In 2001, 610 thousand acres were planted in cotton, mostly in West Tennessee (US Department of Agriculture, 2001A; Figure 1). In 2000, cash receipts from cotton lint production totaled more than $168 million, second only to Tobacco among Tennessee crops (Tennessee Department of Agriculture, 2001).

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

The adoption of precision farming technologies depends on the characteristics of the decision-maker, the farm, and the cotton market. Of the 1,156 Tennessee cotton producers in 1997 (US Department of Agriculture, 1999), 277 producers owned all their farmland, while 176 consider themselves tenants. Tennessee cotton producers farmed an average of 408 acres of cotton per year, with 149 producers planting less than 24 acres of cotton, and 127 producers planting more than 1000 acres. Most cotton farming operations (78%) were family or individually owned. Twenty-five percent of farmers planting cotton were between 45 and 54 years old, with 23% between 35 and 44 and 21% between 55 and 64 years old. The primary occupation of most cotton producers (79%) was listed as farming. Tennessee cotton producers planted a decade high of 700 thousand acres in 1995. Planting fell to a low of 450 thousand acres in 1998, but increased to 605 thousand acres in 2001 (US Department of Agriculture,

2001B). Yield was also variable during the 1990's, ranging from a high of 726 pounds per acre in 1994 to a low of 425 pounds per acre in 1993. In 2000, 53% of cotton acres were planted using no-till production practices and another 9% were produced using some other conservation tillage practice (US Department of Agriculture, 2001B). Prices also varied widely during this period, increasing to a high of $0.75/pound of lint in 1997 and decreasing to a low of $0.44/pound in 1999 (Tennessee Department of Agriculture, 2000).

The future of precision farming in cotton production depends on how producers view this set of new technologies and how willing they are to improve current management practices. 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 Tennessee.

Objectives

The objectives of this study were 1) to determine attitudes toward and current use of precision farming technologies by Tennessee cotton producers and 2) to examine Tennessee cotton producers' willingness to pay for a cotton yield monitoring system.

Methods

Survey Methods

A mail survey of cotton producers located in Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee was conducted in January and February of 2001 to establish the

current use of precision farming technologies in these Southeastern states. This report provides information dealing with the Tennessee portion of the survey.

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 general mail survey procedures (1978), 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 mailing list of 919 potential Tennessee cotton producers for the 1999-2000 season was furnished by the Cotton Board in Memphis, Tennessee (Skorupa, 2000). Of the 919 questionnaires mailed, 30 were returned undeliverable and 50 indicated they were not cotton farmers or had retired, giving a total of 839 cotton producers in Tennessee. Of those cotton producers, 152 individuals provided data. Assuming the remaining non-respondents to the survey were active cotton producers, the usable response rate was 18%.

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 monitor without a yield monitor. A farmer using the former 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. They reported the farm-management value of the technologies they used and the factors that prompted their decision 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 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 they thought precision farming technologies were profitable on their fields and, if not, listed the technologies they planned to discontinue. Adopters indicated whether they 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 asked about the future of precision farming; if they would prefer to own or lease equipment; and to give their best estimate of the

typical purchase price of a cotton yield monitoring system with GPS. They were asked to 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. Respondents were first asked if they currently owned a cotton picker and the size of the picker. They were then asked if they would be willing to purchase a cotton yield monitoring system for their existing cotton picker for the stated price. Respondents also indicated if they were considering purchasing or leasing a new cotton picker and the size of the picker. They then indicated their willingness to purchase an optional cotton yield monitoring system for the stated price. 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 several characteristics of the respondents and their farming operations with data from the 1997 Census of Agriculture (US Department of Agriculture, 1999) and the National Agricultural Statistics Service (US Department of Agriculture, 2001B). The second section presents information about the use of precision farming technologies by cotton farmers who have adopted these technologies in Tennessee. 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 Survey Data with Secondary Data Sources

The distribution of respondents across Tennessee counties (Figure 2 and Appendix II, Table 1) corresponded closely with the 1997 distribution of cotton farmers across counties (US Department of Agriculture, 1999). In the 1997 Census, 62% of the 1,156 cotton producers were located in five counties: Crockett (16%), Haywood (15%), Gibson (14%), Dyer (9%), and Tipton (8%) Counties.

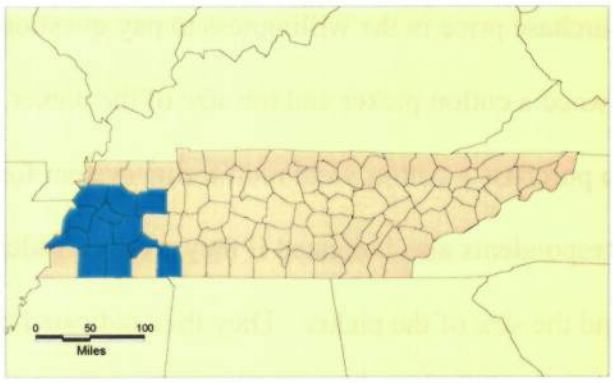


Figure 2. Counties where respondents were located

Of the 152 farmers who responded to the survey, 56% were from those five counties: Crocket (16%), Haywood (12%), Gibson (11%), Dyer (8%), and Tipton (9%) Counties. The largest percentage differences (3%) between survey and Census data were for Haywood and Gibson Counties. Comparing Figures 1 and 2 demonstrates that survey responses corresponded closely with the geographic distribution of cotton acreage across the state.

The average age of the respondents (50 years) was younger than the average age of cotton producers reported in the Census (55 years). Figure 3 shows the age distributions for cotton producers as reported in the 1997 Census compared with the ages of the 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 (10%) than were represented in the 1997 Census (14%) for this age category. Similarly,

respondents who were 65 years of age or older were a smaller percentage of all respondents (10%) than reported in the Census for this age category (14%). 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 34% and 25% for the survey and the Census, respectively. Results indicate that survey respondents were concentrated more in the middle age groups than was found in the 1997 Census.

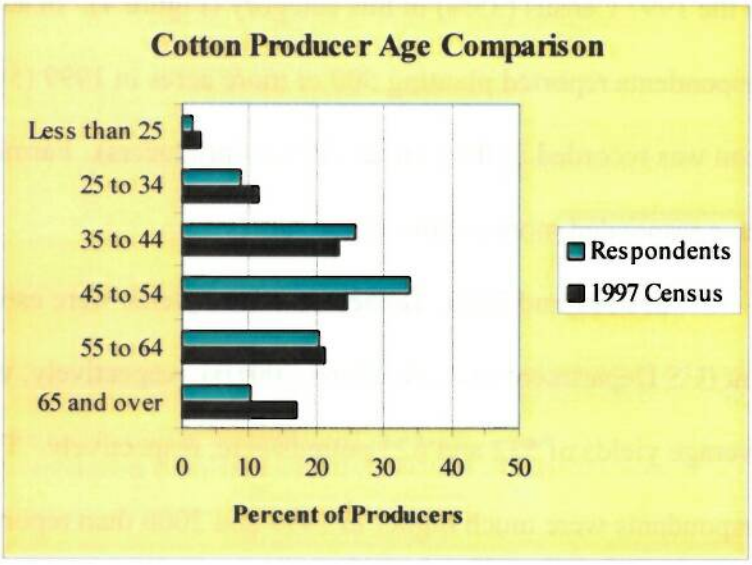


Figure 3. Age distribution of respondents compared with the 1997 Agricultural Census

Survey respondents reported planting 693 and 753 acres of cotton per farm in 1999 and 2000, respectively, compared with an average planted acreage of 408 acres per farm reported in the 1997 Census (US Department of Agriculture, 1999). A smaller percentage of cotton producers who grew less than 99 acres of cotton responded to the survey (19% and 14% for 1999 and 2000, respectively) compared with the percentage of producers reported

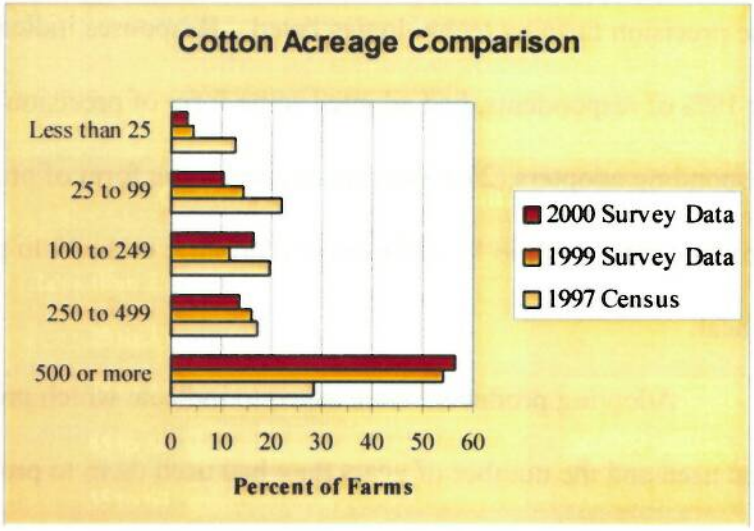


Figure 4. Cotton acres planted per farm for survey respondents compared with the 1997 Agricultural Census

in the 1997 Census (35%) in this category (Figure 4). In addition, larger percentages of survey respondents reported planting 500 or more acres in 1999 (54% of respondents) and 2000 (56%) than was recorded in the Census (29% of producers). Farmers with larger acreages appear to have responded more readily to the survey.

In 1999 and 2000, Tennessee cotton yields were estimated at 505 and 603 pounds/acre of lint (US Department of Agriculture, 2001B), respectively, while survey respondents reported average yields of 532 and 623 pounds/acre, respectively. Thus, acreages reported by survey respondents were much higher in 1999 and 2000 than reported by the National Agricultural Statistics Service (US Department of Agriculture, 2001B) in those years, but yields reported by respondents were only slightly higher than estimates from the National Agricultural Statistics Service for 1999 (5% higher) and 2000 (3% higher).

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 of the precision farming technologies listed. Responses indicated that 29 of the 152 respondents, or 19% of respondents, had adopted some form of precision farming technology. Almost all responding adopters (27 farmers) had used some form of precision farming technology to produce cotton, while 15 had used it to produce corn, 19 to produce soybeans, and 13 to produce wheat.

Adopting producers were asked to indicate which 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 on cotton by the most farmers were grid soil sampling by 14 farmers for an average of 7 years, soil survey maps by 11 farmers for 13 years, variable rate

growth regulator application by 10 farmers for 11 years, and variable rate nitrogen application by 9 farmers for 13 years (Appendix II, Table 2). Only one farmer used yield monitoring with GPS and one used yield monitoring without GPS. Variable rate phosphorus and potassium application was used on cotton by 8 farmers for an average of 10 years.

The precision farming technologies used most in corn production were yield monitoring without GPS by 6 farmers for an average of 4 years, yield monitoring without a yield monitor by 6 farmers for 19 years, soil survey maps by 6 farmers for 17 years, grid soil sampling by 4 farmers for 7 years, and management zone soil sampling by 4 farmers for 16 years (Appendix II, Table 3).

The technologies used on soybeans by the most farmers were soil survey maps by 9 farmers for an average of 15 years, yield monitoring without a yield monitor by 7 farmers for 21 years, grid soil sampling by 7 farmers for 7 years, and management zone soil sampling by 6 farmers for 17 years (Appendix II, Table 4). Yield monitoring with GPS was used by 2 farmers for an average of 1 year, while yield monitoring without GPS was used by 4 farmers for an average of 2 years.

The most used precision farming technologies in wheat production were yield monitoring without a yield monitor by 7 farmers for an average of 21 years, soil survey maps by 6 farmers for 17 years, and management zone soil sampling by 5 farmers for 18 years (Appendix II, Table 5). Yield monitoring with GPS was used by only one farmer and yield monitoring without GPS was used by 4 farmers for an average of 2 years. Grid soil sampling was used by 3 farmers for 3 years.

Fewer adopters used yield monitoring with or without GPS on cotton than on the other crops. This finding was not unexpected because accurate yield monitoring technologies have

only recently become commercially available for cotton production, while they have been available for corn, soybeans, and wheat for a number of years. Yield monitoring without a yield monitor and soil survey maps were also important for adopters on all 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 6 of Appendix II (survey question 2). Average scores given by adopting respondents were highest for "Improving yields" (4.75), "Maintaining better soil test, yield, and financial records", which received average scores of 4.58, 4.50, and 4.46, respectively, and for "Discovering a need for drainage" (4.14). "Quit farming a portion of a field or an entire field" (3.04) and "Discovering a need for leveling" (3.08) were least important to adopters. Nevertheless, 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 three or better.

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 (4.59 average score), with 75% of respondents considering it very important and only 3% indicating it was not important to their decision (Appendix II, Table 7). Environmental benefits received the second highest average score of 3.86, which was considerably lower than the average score received for profit, but still more than moderately important. The fear of being left behind, which had an average score of only 2.51, was least likely to persuade producers to practice precision farming.

Soil Sampling Technologies

Questions 4 through 8 of the survey questioned adopting producers about their soil sampling practices. Forty-two percent of responding adopters did the majority of their soil sampling within management zones, 19% did grid soil sampling, while only 8% pulled cores from grids within management zones (Appendix II, Table 8). Thirty-one percent of adopters used none of the three precision sampling choices listed in question 4.

The majority (54%) of responding adopters in Tennessee collected their own soil samples (Appendix II, Table 8). Forty-two percent used a fertilizer or chemical dealer to collect samples, while only 4% used a consultant. Ninety percent of adopters pulled soil cores from around the center point of the grid or management zone, while only 10% of adopters collected cores randomly within a grid or management zone.

The average management zone size was 13 acres and ranged between five and 25 acres (Appendix II, Table 9). On average, eight soil cores were taken per management zone, with a range of one to 25 cores per zone. The typical grid size for adopters averaged six acres and ranged from two to 15 acres. On average, seven soil cores were taken per grid, ranging from one to ten cores.

Variable Rate Input Application Technologies

Cotton producers who had adopted some form of precision farming technology were asked in question 9 about their use of variable rate application technologies on cotton. The majority of adopters did not use variable rate application technologies on cotton (Appendix II, Table 10). Twenty-six percent of responding adopters used variable rate lime application, followed by variable rate nitrogen application (25%), variable rate phosphorus and potassium

application (24%), and variable rate growth regulator application (24%). No responding adopter had used variable rate technology for manure application, nematicide application, or irrigation.

Of those responding adopters who used variable rate nitrogen application, 50% reported no change in total nitrogen use, 25% reported an increase, and 25% reported a decrease in nitrogen use (Appendix II, Table 10). Twenty-nine percent of responding adopters reported an increase in total input use with variable rate phosphorus and potassium application. Another 29% reported a decrease in inputs, while 43% saw no affect on total phosphorous and potassium use. Eighty-six percent of responding adopters reported a decrease in total lime use when using variable rate application, with only 14% reporting an increase in lime use. Total growth regulator use also decreased with variable rate application for 43% of responding adopters, while 29% experienced an increase and another 29% 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-two percent of the 19 responding adopters experienced an increase in yields, 11% reported a decrease, and 58% indicated no change in cotton yields (Appendix II, Table 11). In survey question 11, adopters were asked to indicate the magnitude of the change in yields. Responses to this question were insufficient in number to report.

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. Five respondents listed a total of seven pieces of equipment. Two Ag Leader grain yield monitors were purchased in 1998 and 2000 for an average price of $3,100. The only problem encountered

was with a moisture sensor on one of the grain yield monitors. Other producers listed cotton pickers and combines, but did not list precision farming equipment. No responses were given for equipment lease rates.

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 (4.13), grid soil sampling (4.00), variable rate phosphorous and potassium application (3.86), and variable rate nitrogen application (3.83) (Appendix II, Table 12). Information gathered from farm dealers was not helpful for yield monitoring without a yield monitor (1.75), remote sensing using aerial photography (2.00) or satellite imagery (1.00), mapping topography, slope, soil depth, etc. (2.33), and variable rate seed application (2.33).

In Table 13 (Appendix II), results show that crop consultants were helpful in learning about grid soil sampling (4.25), variable rate nitrogen (4.00), phosphorus and potassium (4.00), growth regulator (3.67), and defoliant (3.67) applications. They did not provide helpful information in learning about remote sensing using satellite imagery (1.00), on-the-go sensing (1.00), yield monitoring without a yield monitor (1.67), remote sensing using aerial photography (2.00), variable rate seed application (2.00), management zone soil sampling (2.33), plant tissue testing (2.50), and variable rate herbicide application (2.67).

Adopters considered the Extension Service and universities helpful sources of information in learning about soil survey maps (4.33), mapping topography, slope, soil depth, etc. (4.25), grid soil sampling (4.17), yield monitoring with GPS (4.17), yield monitoring without

GPS (4.14), and least helpful in learning about on-the-go sensing (1.00), variable rate seed application (1.00), and remote sensing using satellite imagery (1.00) or aerial photography (2.00) (Appendix II, Table 14).

Other farmers were not generally rated as helpful sources of information in learning about precision farming technologies. Average scores were highest for variable rate nitrogen (3.80), phosphorous and potassium (3.67), defoliant (3.67) and herbicide (3.67) application, and yield monitoring with GPS (3.60) (Appendix II, Table 15). Lowest scores were for remote sensing using satellite imagery (1.00), mapping topography, slope, soil depth, etc. (1.00), on-the-go sensing (1.00), and variable rate lime application (1.33).

The majority of adopters indicated that trade shows were not helpful sources of information in learning about precision farming technologies (Appendix II, Table 16). The only average score above three was for yield monitoring with GPS (3.50). Similarly, the Internet and news media were not considered helpful sources of information (Appendix II, Tables 17 and 18). For the Internet, the only average score above three was for variable rate phosphorous and potassium application (3.33), and for the news media, the only average scores above three were for variable rate nitrogen (3.80) and phosphorous and potassium (3.33) application.

Table 19 (Appendix II) summarizes the average scores for learning about all precision farming technologies considered across all responding adopters. The Extension Service and universities (3.50) and farm dealers (3.24) and were the most helpful, while the Internet (2.07) and trade shows (1.98) 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 on their farms. Fifty-three percent of responding adopters had used off-farm precision farming services (Appendix II, Table 20). Precision farming adopters who had used off-farm precision farming services were asked to identify the services they had used or employed and the cost of those services (survey question 15). The majority of adopters reported receiving management and technical advice concerning the precision farming technologies they used (Appendix II, Table 21). The largest majority (90%) of responding adopters received advice concerning grid soil sampling. The average cost of advice on grid soil sampling was $3.44/acre. Average cost for advice on soil survey maps was $1.25/acre and for variable rate lime application it was $1.67/acre. Almost all responding adopters indicated that they would purchase the advice again.

The most popular custom services hired by adopters are presented in Table 22 of Appendix II. Ninety percent of grid soil sampling adopters hired this service rather than doing their own sampling. All but one of six adopters of variable rate phosphorous and potassium application had custom hired this service and all but one of eight adopters of variable rate lime application had hired custom this service. The average costs of custom hiring the services were $4.11/acre for grid soil sampling, $4.00/acre for variable rate phosphorous and potassium application, and $4.17/acre for variable rate lime application. All responding farmers indicated they would purchase the service 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 percent of responding adopters thought precision farming was profitable (question 16) on their fields (Appendix II, Table 23). Adopters who found precision farming unprofitable were given an opportunity in question 17 to

list the technologies they planned to discontinue; however, no farmers responded to this question. Thirty-one percent of adopters thought they had experienced an improvement in environmental quality (question 18) as a result of precision farming (Appendix II, Table 23). In question 19, adopters were given an opportunity to list the improvements in environmental quality they had observed. Seven producers answered this question. Among others, their responses included, "less nitrogen use", "lower fertilizer rates", "less fertilizer run-off", "better drainage", "leaving out areas that are not profitable", "better soil texture-tilth", "more organic matter", and "less money spent on herbicides".

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 their equipment. Eighty-five percent of adopting producers and 64% of non-adopting producers thought precision farming would be profitable for them to use in the future (Appendix II, Table 24). For those respondents who believed it would be profitable, 61% of adopters and 58% 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 five years in the future. The level of importance ranged from 1 (not important) to 5 (very important). Adopters consistently rated the importance of precision farming five years in the future higher than did non-adopters (Appendix II, Table 25). For cotton production, the average scores for adopters and non-adopters were 3.93 and 3.48, respectively; for corn

production, they were 3.60 and 3.40, respectively; for soybean production, they were 3.12 and 2.92, respectively; and for wheat production, they were 3.32 and 3.12, respectively.

Perceived Price of a Cotton Yield Monitoring System

In question 22, producers were asked to report their best estimate of the typical purchase price for a cotton yield monitoring system with GPS. The average purchase price given by adopters was $7,200, while the average price given by non-adopters was $343 less at $6,857 (Appendix II, Table 26). 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, 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 on an existing picker. Ninety-three percent of adopters and 83% of non-adopters owned a cotton picker (Appendix II, Table 27). Of the adopters who responded to the second part of question 30, 88% owned a four-row cotton picker, none owned a five-row picker, and 12% owned a six-row picker. Ninety percent of responding non-adopters owned a four-row picker, 6% owned a five-row picker, 4% owned a six-row picker.

Table 28 (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). Clearly, the percentage of respondents willing to purchase the yield monitoring system for their existing cotton picker was inversely related to the price of the system. The percentages of respondents in

the "Don't know" and "Don't own a 4-5-row picker" remained about the same as the price increased.

Survey question 32 asked all cotton farmers if they were considering purchasing or leasing a new cotton picker. The purpose of this question was to determine if the respondent was a candidate for purchasing an optional yield monitoring system with the new picker. Only 11% of responding adopters and 8% of responding non-adopters were considering purchasing or leasing a new picker (Appendix II, Table 27). All responding adopters were considering purchasing or leasing a new 6-row picker, while 64% of non-adopters were thinking about purchasing or leasing a new 4-row picker.

Table 29 (Appendix II) reports respondents' willingness to purchase or lease an optional yield monitoring system at specified dollar amounts when they purchase or lease a new 4, 5, or 6-row cotton picker (survey question 33). The data show a downward trend in the percentage of farmers who would be willing to purchase an optional yield monitoring system as the price increases. The trend upward in the percentage of respondents who were unwilling to purchase or lease the system is not as clear as in the case of retrofitting a yield monitoring system to an existing picker. In this case, the percentage of respondents in the "Don't know' and "Don't intend to purchase or lease a new picker" increases with the price. Nevertheless, the price of a cotton yield monitoring system appears to affect farmers' willingness to pay for the system.

Respondent and Farm Characteristics for Adopters and Non-Adopters

Farm Characteristics

Respondents were asked to describe their farm in 2000 (questions 24 through 26). The average precision farming adopter owned 624 acres, share rented 975 acres under a three-year rental agreement, and cash rented 737 acres under a two-year rental agreement. Compared with

adopters, the average non-adopter owned the same amount of acreage (624 acres), share rented less acreage (589 acres) for three years, and cash rented less acreage (336 acres) for two years (Appendix II, Table 30).

Producers were asked to provide the county where the majority of their farm was located (survey question 27). The greatest numbers of responses for precision farming adopters came from Lauderdale (5 adopters), Crocket (4 adopters), Dyer (3 adopters), Gibson (3 adopters), and Tipton (3 adopters) Counties, while the largest numbers of non-adopters came from Crockett (20 non-adopters), Haywood (17 non-adopters), Gibson (14 non-adopters), Fayette (12 non-adopters), and Tipton (10 non-adopters) Counties (Appendix II, Table 1).

Producers reported acres planted and estimated yields for the crops they produced in 1999 and 2000 (survey question 28). On average, adopters planted 1,087 acres of cotton in 1999 with yield averaging 553 lbs/acre (Appendix II, Table 31). Non-adopters planted 599 acres per farm in 1999, nearly one-half the acres planted by adopters. Cotton yields averaged 526 lbs/acre for non-adopters, which was 27 lbs/acre less than adopters. On average, planted acreage and yield increased in 2000 for both responding groups (Appendix II, Table 32). Adopters planted 1,202 acres yielding 652 lbs/acre, while non-adopters received yields of 615 lbs/acre on 638 acres per farm. Again in 2000, adopters planted twice as many acres of cotton as non-adopters. In 1999 and 2000, acreages planted to corn, soybeans, and wheat were higher for adopters than non-adopters (Appendix II, Tables 31 and 32), but yields were quite similar for these crops among both groups of respondents.

Producers were asked to provide annual average yields for the most productive one-third, the average, and the least productive one-third of typical cotton, corn, soybean, and wheat fields they farmed (question 29). Adopters reported similar or higher yields with lower standard

deviations than non-adopters for all crops in all three yield categories (Appendix II, Table 33). Nevertheless, for a typical field, adopters reported more yield variability than non-adopters for all crops. For example, the difference between the yield reported by adopters for the most productive one-third and the least productive one-third of a typical cotton field was 382 lb/acre, while this difference was 357 lb/acre for non-adopters. As another example, for a typical corn field, these yield ranges were 72 bu/acre and 66 bu/acre for adopters and non-adopters, respectively.

Table 34 (Appendix II) presents producers' responses to survey question 34 concerning livestock. About the same percentage of adopters (36%) and non-adopters (33%) reported that they owned livestock. Only 8% of responding cotton producers applied manure to their fields and none of them was an adopter of precision farming technologies.

Respondent Characteristics

Producers were queried about their age, years of farming experience, education, and computer usage (survey questions 35 through 38). The average age (question 35) of a precision farming adopter was 47 years and varied from 29 to 63 years. Non-adopters averaged 50 years of age, ranging from 24 to 82 years (Appendix II, Table 35). Precision farming adopters had farmed an average of 26 years, while non-adopters had farmed an average of 28 years (survey question 36). Years of farming ranged from ten to 63 years for adopters and four to 76 years for non-adopters (Appendix II, Table 35). The overwhelming majority of adopters (97%) and non-adopters (95%) completed high school (question 37) and both groups completed an average of two years of college (Appendix II, Table 36). The majorities of adopters (83%) and non-adopters (72%) owned a computer (question 38) (Appendix II, Table 37). Seventy-five 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 38, 39, and 40). Farming was the primary source of income for all precision farming adopters, except 3 of 10 adopters in the $50,000 to $99,999 income category (Appendix II, Table 39). Total household income in 2000 ranged from $50,000 to $99,999 for 36% of adopters and less than $50,000 for 21% of adopters. Fourteen percent of adopters had household incomes greater than $500,000 in 2000.

Farming was also the primary income source for most non-adopters (Appendix II, Table 40). However, 35% of all responding non-adopters indicated that farming was not their primary source of household income, and all of these non-adopters earned household incomes less than $150,000. A larger percentage of non-adopters (72%) than adopter (57%) had household incomes less than $100,000 in 2000. Only 6% of non-adopters reported total household incomes of $500,000 or greater.

Producers indicated the one statement that best described their farm-planning goal in question 40. Sixty-one percent of adopters and 50% of non-adopters stated their farm-planning goal was to acquire enough farm assets to generate sufficient income for family living (Appendix II, Table 41). Twenty-five percent of adopters wanted to expand the size of their operation by acquiring additional resources and none of the responding adopters were considering selling the farm and moving to a different career. Ten percent of non-adopters wanted to expand the size of their operation, 27% were thinking about retirement and transferring the farm to the next generation, and 13% were considering selling the farm.

Closing Remarks

The objectives of this study were 1) to determine attitudes toward and current use of precision farming technologies by Tennessee cotton producers and 2) to examine Tennessee cotton producers' willingness to pay for a cotton yield monitoring system. Cotton producers are confronted everyday with information concerning the rapidly growing precision farming industry. Most responding cotton producers use computers for farm management decisions, believe precision farming will be profitable in the future, and those producers who adopt these technologies do so to increase profit. Cotton producers are listening to farm dealers, Extension Service and university research personnel, and crop consultants in making decisions about precision farming. As more information becomes available, cotton producers will have greater opportunities to make more informed decisions about the use of these technologies on their farms. Findings from this and other studies that investigate the current use and future prospects 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.

References

Ag Leader Technology. 2001. 2001 List Prices. 2202 South Riverside Drive, Ames, IA 50010.

Beuerlein, J., and W. Schmidt. 1993. Grid soil sampling and fertilization. Ohio State Univ. Ext., Agron. Tech. Rep. 9302, Ohio State Univ., Columbus.

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

Fiez, T.E., B.C. Miller, and W.L. Pan. 1994. Assessment of spatially variable nitrogen fertilizer management in winter wheat. *J. Prod. Agric.* 7: 86-93.

Gerloff, D.C. 2001A. "Cotton Budgets for 2001." Department of Agricultural Economics, Agricultural Extension Service, University of Tennessee, AE 01-42.

Gerloff, D.C. 2001B. "Field Crop Budgets for 2001." Department of Agricultural Economics, Agricultural Extension Service, University of Tennessee, AE 01-43.

Hammond, M.W. 1993. Cost analysis of variable fertility management of phosphorous and potassium for potato production in central Washington. p. 213-228. *In* P.C. Robert et al. (ed). Soil specific crop management. ASA Misc. Publ. ASA, CSSA, and SSSA, Madison, WI.

Lambert D., J. Lowenberg-DeBoer. 2000. Precision Farming Profitability Review. Site-Specific Management Center. West Lafayette, IN: Purdue University.

Lowenberg-DeBoer, J. 1994. Economics of precision farming. Agron. Research Center Field Day. Purdue Univ., West Lafayette, IN.

Lowenberg-DeBoer, J. 1999. Risk management potential of precision farming technologies. *J. Agric. Appl. Econ.* 31,2: 275-285.

Malzer, G.L. 1996. Profitability of variable rate N on corn. p. 6-7. *In* Proc. 1996 Information Agric. Conf., Urbana, IL. Phosphate and Potash Inst. and Found. for Agron. Res., Norcross, GA.

Schnitkey, G., J. Hopkins, and L. Tweeten. 1997. An economic evaluation of precision fertilizer applications on corn-soybean fields. *In* P.C. Roberts et al. (ed). Proc. 3rd international conference on precision agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.

Skorupa, B. 2000. Cotton Board, 871 Ridgeway Loop, Ste. 100, Memphis, TN 38120-4019.

Snyder, C., T. Schroeder, J. Havlin, and G. Kluitenberg. 1997. An economic analysis of variable rate nitrogen management. *In* P.C. Roberts et al. (ed). Proc. 3rd international conference on precision agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.

Swinton, S. and J. Lowenberg-DeBoer. 1998. Evaluating the profitability of site-specific Farming. *J. Prod. Agric.* 11: 439-446.

Tennessee Department of Agriculture. 2000. Tennessee Agriculture, 2000. National Agricultural Statistics Service.

Tennessee Department of Agriculture. 2001. Farm Facts. Tennessee Agricultural Statistics Service. Released: Vol. 01, No. 15, August 7.

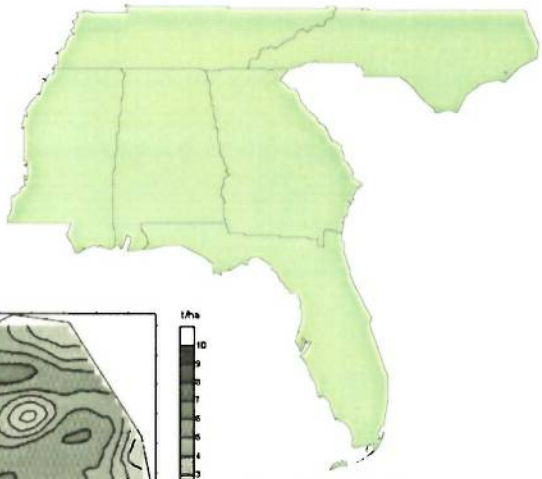
US Department of Agriculture. 1999. 1997 Census of Agriculture: Tennessee State and County Data. Vol. 1, Geographic Area Series, Part 42. National Agricultural Statistics Service, Washington, D.C.

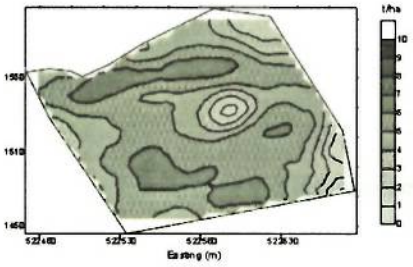
US Department of Agriculture. 2001A. National Agriculture Statistics Service. www.usda.mannlib.cornell.edu/reports/nassr/field/pcp-bba/acrg2001.pdf.

US Department of Agriculture. 2001B. National Agriculture Statistics Service. www.nass.usda.gov/tn/ct052101.pdf.

Appendix I: The Questionnaire

2001 Southern Precision Farming Survey





Lead Researchers

Alabama – Bob Goodman
Cotton Incorporated – Jeanne Reeves
Florida – Sherry Larkin
Georgia – Don Shurley
Mississippi – Steve Martin
North Carolina – Michele Marra
Tennessee – Roland Roberts

For contact number see cover letter.

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.				
d.				
e.				

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

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

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

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

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

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

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

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

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

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

Resume here

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

35. Age? _____

36. Number of years farming? _____

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

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

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

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

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. Primary county of cotton farm business reported by primary decision maker for Tennessee cotton farms - 2001 Southern Precision Farming Survey[a]

County	1997 Census of Agriculture[b]	Number of Usable Surveys	Precision Farming Adopters	Precision Farming Non-adopters
Carroll	41 (4%)[c]	7 (5%)	1 (4%)	6 (5%)
Chester	21 (2%)	4 (3%)	1 (4%)	3 (3%)
Crockett	181 (16%)	24 (16%)	4 (14%)	20 (17%)
Dyer	99 (9%)	12 (8%)	3 (11%)	9 (8%)
Fayette	84 (7%)	14 (9%)	2 (7%)	12 (10%)
Franklin	5 (0%)	0	0	0
Gibson	160 (14%)	17 (11%)	3 (11%)	14 (12%)
Giles	4 (0%)	1 (1%)	1 (4%)	0
Hardeman	27 (2%)	3 (2%)	2 (7%)	1 (1%)
Hardin	0	3 (2%)	0	3 (3%)
Haywood	170 (15%)	19 (12%)	2 (7%)	17 (15%)
Henderson	11 (1%)	2 (1%)	0	2 (2%)
Lake	21 (2%)	2 (1%)	0	2 (2%)
Lauderdale	87 (8%)	9 (6%)	5 (18%)	4 (3%)
Lawrence	0	1 (1%)	0	1 (1%)
Lincoln	10 (1%)	2 (1%)	0	2 (2%)
Madison	86 (7%)	7 (5%)	1 (4%)	6 (5%)
McNairy	3 (0%)	0	0	0
Obion	11 (1%)	1 (1%)	0	1 (1%)
Rutherford	10 (1%)	2 (1%)	0	2 (2%)
Shelby	25 (2%)	2 (1%)	0	2 (2%)
Tipton	91 (8%)	13 (9%)	3 (11%)	10 (9%)
Other Counties	9 (1%)	7 (5%)[d]	1 (4%)	6 (5%)
Total	1156 (100%)	152 (100%)	29 (100%)	117 (100%)

[a] Survey question 27. [b] Reported in the 1997 Census of Agriculture, USDA. [c] Numbers in parenthesis indicate the percentage of respondents who gave the associated answer. [d] No county indicated by respondents.

Table 2. Years of experience with alternative precision farming technologies for cotton reported by Tennessee 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	1	--	--	--	--
Yield monitoring - without a yield monitor	8	20	9	6	30
Soil sampling - grid	14	7	10	1	35
Soil sampling - management zone	8	13	10	1	30
Remote sensing - aerial photos	1	--	--	--	--
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	11	13	10	1	30
Mapping topography, slope, soil depth, etc.	3	10	13	1	25
Plant tissue testing	2	6	--	--	--
On-the-go sensing	1	--	--	--	--
Variable rate nitrogen application	9	13	11	1	30
Variable rate phosphorous and potassium application	8	10	11	1	30
Variable rate lime application	8	6	8	1	25
Variable rate seed application	3	13	8	6	22
Variable rate growth regulator application	10	11	5	5	20
Variable rate defoliant application	8	10	6	1	20
Variable rate fungicide application	1	--	--	--	--
Variable rate herbicide application	7	16	12	1	30
Variable rate insecticide application	3	18	14	3	30
Variable rate irrigation	0	0	0	0	0

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

Table 3. Years of experience with alternative precision farming technologies for corn reported by Tennessee 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]	2	1	--[c]	--	--
Yield monitoring - without GPS	6	4	2	1	5
Yield monitoring - without a yield monitor	6	19	8	6	30
Soil sampling - grid	4	7	9	1	20
Soil sampling - management zone	4	16	5	10	20
Remote sensing - aerial photos	0	0	0	0	0
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	6	17	11	2	30
Mapping topography, slope, soil depth, etc.	1	--	--	--	--
Plant tissue testing	0	0	0	0	0
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	3	23	8	15	30
Variable rate phosphorous and potassium application	3	20	13	6	30
Variable rate lime application	3	9	14	1	25
Variable rate seed application	2	13	--	--	--
Variable rate growth regulator application	0	0	0	0	0
Variable rate defoliant application	0	0	0	0	0
Variable rate fungicide application	0	0	0	0	0
Variable rate herbicide application	3	18	10	10	30
Variable rate insecticide application	0	0	0	0	0
Variable rate irrigation	0	0	0	0	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 soybeans reported by Tennessee 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]	2	1	--[c]	--	--
Yield monitoring - without GPS	4	2	1	1	3
Yield monitoring - without a yield monitor	7	21	9	6	30
Soil sampling - grid	7	7	9	1	20
Soil sampling - management zone	6	17	8	10	30
Remote sensing - aerial photos	1	--	--	--	--
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	9	15	9	2	30
Mapping topography, slope, soil depth, etc.	1	--	--	--	--
Plant tissue testing	0	0	0	0	0
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	1	--	--	--	--
Variable rate phosphorous and potassium application	4	16	14	1	30
Variable rate lime application	3	9	14	1	25
Variable rate seed application	1	--	--	--	--
Variable rate growth regulator application	0	0	0	0	0
Variable rate defoliant application	1	--	--	--	--
Variable rate fungicide application	0	0	0	0	0
Variable rate herbicide application	4	20	13	1	30
Variable rate insecticide application	0	0	0	0	0
Variable rate irrigation	0	0	0	0	0

[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 wheat reported by Tennessee 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	4	2	1	1	3
Yield monitoring - without a yield monitor	7	21	9	6	30
Soil sampling - grid	3	3	3	1	6
Soil sampling - management zone	5	18	8	10	30
Remote sensing - aerial photos	0	0	0	0	0
Remote sensing - satellite images	0	0	0	0	0
Soil survey maps	6	17	11	2	30
Mapping topography, slope, soil depth, etc.	1	--	--	--	--
Plant tissue testing	0	0	0	0	0
On-the-go sensing	0	0	0	0	0
Variable rate nitrogen application	3	14	12	1	25
Variable rate phosphorous and potassium application	2	16	--	--	--
Variable rate lime application	3	9	14	1	25
Variable rate seed application	0	0	0	0	0
Variable rate growth regulator application	0	0	0	0	0
Variable rate defoliant application	0	0	0	0	0
Variable rate fungicide application	0	0	0	0	0
Variable rate herbicide application	1	--	--	--	--
Variable rate insecticide application	0	0	0	0	0
Variable rate irrigation	0	0	0	0	0

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

Table 6. Value of precision farming technologies in management decision making reported by Tennessee 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	28	2 (7%)[c]	0	2 (7%)	12 (43%)	12 (43%)	4.14
Discovering a need for leveling	25	1 (4%)	7 (28%)	9 (36%)	5 (20%)	3 (12%)	3.08
Discovering a need for improved soil tilth	25	1 (4%)	1 (4%)	6 (24%)	13 (52%)	4 (16%)	3.72
Maintaining a record of field conditions	25	0	0	8 (32%)	11 (44%)	6 (24%)	3.92
Conducting rental negotiations	25	1 (4%)	4 (16%)	4 (16%)	11 (44%)	5 (20%)	3.60
Deciding on the purchase of crop insurance (or establishing crop insurance units)	22	3 (14%)	1(5%)	2 (9%)	12 (55%)	4 (18%)	3.59
Maintaining better yield records	28	0	1 (4%)	1 (4%)	9 (32%)	17 (61%)	4.50
Maintaining better soil test records	31	0	0	0	13 (42%)	18 (58%)	4.58
Maintaining better financial records	28	0	1 (4%)	2 (7%)	8 (29%)	17 (61%)	4.46
Improving yields	32	0	0	1 (3%)	6 (19%)	25 (78%)	4.75
Reducing N use	27	2 (7%)	1 (4%)	6 (22%)	14 (52%)	4 (15%)	3.63
Reducing P&K use	32	1 (3%)	0	9 (28%)	14 (44%)	8 (25%)	3.88
Reducing herbicide use	26	1 (4%)	1 (4%)	6 (23%)	8 (31%)	10 (38%)	3.96
Reducing insecticide use	24	2 (8%)	1 (4%)	6 (25%)	5 (21%)	10 (42%)	3.83
Reducing plant growth regulator use	27	1 (4%)	2 (7%)	6 (22%)	12 (44%)	6 (22%)	3.74
Reducing fungicide use	25	3 (12%)	2 (8%)	6 (24%)	10 (40%)	4 (16%)	3.40
Reducing defoliant use	24	2 (8%)	2 (8%)	5 (21%)	10 (42%)	5 (12%)	3.58
Quit farming a portion of a field or an entire field	23	6 (26%)	2 (9%)	6 (26%)	3 (13%)	6 (26%)	3.04

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

Table 7. Factors that influenced the adoption of precision farming practices reported by Tennessee 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	32	1 (3%)[c]	0	2 (6%)	5 (16%)	24 (75%)	4.59
Environmental benefits	29	1 (3%)	3 (10%)	4 (14%)	12 (41%)	9 (31%)	3.86
Be at the forefront of agricultural technology	29	4 (14%)	5 (17%)	8 (28%)	8 (28%)	4 (14%)	3.10
Fear of being left behind	29	8 (28%)	5 (17%)	11 (38%)	3 (10%)	2 (7%)	2.51

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

Table 8. Soil Sampling in Tennessee reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey

Item	Number of Responses	Percentages
How do you do the majority of your soil sampling? [a]	36 Total	100
Management zones	15	42
Grids	7	19
Grids within management zones	3	8
None of the other three choices	11	31
Who collect the soil samples? [b]	24 Total	100
Self	13	54
Consultant	1	4
Fertilizer of chemical dealer	10	42
How were the cores collected? [c]	21 Total	100
Randomly within a grid or management zone	2	10
Around the center point of the grid or management zone	19	90

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

Table 9. Average management zone and grid sizes reported by Tennessee cotton farmers – 2001 Precision Farming Survey

Item	Number of Responses	Average	Standard Deviation	Minimum	Maximum
Average management zone size? (acres) [a]	17	13	7	5	25
Soil cores taken per management zone [b]	16	8	8	1	25
Typical grid size (acres) [a]	7	6	4	2	15
Soil cores taken per grid [b]	6	7	4	1	10

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

Table 10. Use of variable rate application technology on cotton fields reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey [a]

	Did you use variable rate technology to apply?			If you used variable rate technology, how did it affect total input use?			
Input	Number of Responses	Yes	No	Number of Responses	Increase	Decrease	Same
N fertilizer	36	9 (25%)[b]	27 (75%)	8	2 (25%)	2 (25%)	4 (50%)
P&K fertilizer	34	8 (24%)	26 (76%)	7	2 (29%)	2 (29%)	3 (43%)
Lime	35	9 (26%)	26 (74%)	7	1 (14%)	6 (86%)	0
Manure application	32	0	32 (100%)	0	0	0	0
Seed	33	3 (9%)	30 (91%)	2	1 (50%)	0	1 (50%)
Herbicide	33	5 (15%)	28 (85%)	5	1 (20%)	1 (20%)	3 (60%)
Insecticide	33	5 (15%)	28 (85%)	4	1 (25%)	1 (25%)	2 (50%)
Nematicide	31	0	31 (100%)	0	0	0	0
Irrigation	31	0	31 (100%)	0	0	0	0
Funigicide	32	2 (6%)	30 (94%)	1	--[c]	--	--
Growth regulator	33	8 (24%)	25 (76%)	7	2 (29%)	3 (43%)	2 (29%)
Defoliant	33	7 (21%)	26 (79%)	6	2 (33%)	1 (17%)	3 (50%)

[a] Survey question 9. [b] Numbers in parenthesis indicate the percentage of respondents who gave the associated answer. [c] Not reported to avoid disclosure.

Table 11. The change in cotton yields following variable rate application reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey

	Number of Responses	Increase	Decrease	Same
Following variable rate application, how did your cotton yields change? [a]	19	6 (32%)[b]	2 (11%)	11 (58%)
	Number of Responses	Average	Minimum	Maximum
If your cotton yields changed, by approximately how much did they change? (lb lint/acre) [c]	c	c	c	c

[a] Survey question 10. [b] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [c] Responses to survey question 11 were insufficient in number to report.

Table 12. Importance of farm dealers as a source of information about precision farming technologies reported by Tennessee 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	7	2 (29%)[c]	1 (14%)	0	0	4 (57%)	3.43
Yield monitoring - without GPS	8	1 (12%)	1 (12%)	1 (12%)	1 (12%)	4 (50%)	3.75
Yield monitoring - without a yield monitor	4	3 (75%)	0	0	1 (25%)	0	1.75
Soil sampling - grid	11	0	1 (9%)	1 (9%)	6 (55%)	3 (27%)	4.00
Soil sampling - management zone	9	3 (33%)	1 (11%)	2 (22%)	0	3 (33%)	2.89
Remote sensing - aerial photos	3	2 (67%)	0	0	1 (33%)	0	2.00
Remote sensing - satellite images	2	2 (100%)	0	0	0	0	1.00
Soil survey maps	7	3 (43%)	2 (29%)	0	1 (14%)	1 (14%)	2.29
Mapping topography, slope, soil depth, etc.	3	2 (67%)	0	0	0	1 (33%)	2.33
Plant tissue testing	2	1 (50%)	0	0	0	1 (50%)	3.00
On-the-go sensing	2	1 (50%)	0	0	0	1 (50%)	3.00
Variable rate nitrogen application	6	0	2 (33%)	0	1 (17%)	3 (50%)	3.83
Variable rate phosphorous and potassium application	7	1 (14%)	0	2 (29%)	0	4 (57%)	3.86
Variable rate lime application	8	1 (12%)	0	1 (12%)	1 (12%)	5 (62%)	4.13
Variable rate seed application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate growth regulator application	4	1 (25%)	0	0	1 (25%)	2 (50%)	3.75
Variable rate defoliant application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate fungicide application	1	--[d]	--	--	--	--	--
Variable rate herbicide application	3	1 (33%)	1 (33%)	0	0	1 (33%)	2.67
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 13. Importance of crop consultants as a source of information about precision farming technologies reported by Tennessee 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	4	1 (25%)[c]	0	0	2 (50%)	1 (25%)	3.50
Yield monitoring - without GPS	6	1 (17%)	0	2 (33%)	1 (17%)	3 (33%)	3.50
Yield monitoring - without a yield monitor	3	2 (67%)	0	1 (33%)	0	0	1.67
Soil sampling - grid	8	1 (12%)	0	0	2 (25%)	5 (62%)	4.25
Soil sampling - management zone	6	3 (50%)	0	2 (33%)	0	1 (17%)	2.33
Remote sensing - aerial photos	3	2 (67%)	0	0	1 (33%)	0	2.00
Remote sensing - satellite images	2	2 (100%)	0	0	0	0	1.00
Soil survey maps	8	1 (12%)	0	2 (25%)	4 (50%)	1 (12%)	3.50
Mapping topography, slope, soil depth, etc.	3	1 (33%)	0	0	1 (33%)	1 (33%)	3.33
Plant tissue testing	2	1 (50%)	0	0	1 (50%)	0	2.50
On-the-go sensing	2	2 (100%)	0	0	0	0	1.00
Variable rate nitrogen application	6	1 (17%)	0	1 (17%)	0	4 (67%)	4.00
Variable rate phosphorous and potassium application	4	1 (25%)	0	0	0	3 (75%)	4.00
Variable rate lime application	5	2 (40%)	0	1 (20%)	0	2 (40%)	3.00
Variable rate seed application	3	2 (67%)	0	0	1 (33%)	0	2.00
Variable rate growth regulator application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate defoliant application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate fungicide application	1	--[d]	--	--	--	--	--
Variable rate herbicide application	3	1 (33%)	1 (33%)	0	0	1 (33%)	2.67
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 14. Importance of the Extension Service and universities as a source of information in learning about the precision farming technologies reported by Tennessee cotton farmers - 2001Southern 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	6	0	0	1 (17%)[c]	3 (50%)	2 (33%)	4.17
Yield monitoring - without GPS	7	0	0	2 (29%)	2 (29%)	3 (43%)	4.14
Yield monitoring - without a yield monitor	4	1 (25%)	0	0	1 (25%)	2 (50%)	3.75
Soil sampling - grid	6	0	1 (17%)	0	2 (33%)	3 (50%)	4.17
Soil sampling - management zone	7	2 (29%)	0	0	2 (29%)	3 (43%)	3.57
Remote sensing - aerial photos	3	2 (67%)	0	0	1 (33%)	0	2.00
Remote sensing - satellite images	2	2 (100%)	0	0	0	0	1.00
Soil survey maps	9	0	0	0	6 (67%)	3 (33%)	4.33
Mapping topography, slope, soil depth, etc.	4	0	0	0	3 (75%)	1 (25%)	4.25
Plant tissue testing	1	--[d]	--	--	--	--	--
On-the-go sensing	2	2 (100%)	0	0	0	0	1.00
Variable rate nitrogen application	5	1 (20%)	0	0	2 (40%)	2 (40%)	3.80
Variable rate phosphorous and potassium application	3	1 (33%)	1 (33%)	0	0	1 (33%)	2.67
Variable rate lime application	3	1 (33%)	0	1 (33%)	1 (33%)	0	2.67
Variable rate seed application	2	2 (100%)	0	0	0	0	1.00
Variable rate growth regulator application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate defoliant application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate fungicide application	1	--	--	--	--	--	--
Variable rate herbicide application	3	1 (33%)	1 (33%)	0	0	1 (33%)	2.67
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 15. Importance of other farmers as a source of information in learning about the precision farming technologies reported by Tennessee 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	5	1 (20%)[c]	0	0	3 (60%)	1 (20%)	3.60
Yield monitoring - without GPS	4	1 (25%)	0	1 (25%)	1 (25%)	1 (25%)	3.25
Yield monitoring - without a yield monitor	4	1 (25%)	0	1 (25%)	2 (50%)	0	3.00
Soil sampling - grid	7	2 (29%)	1 (14%)	1 (14%)	2 (29%)	1 (14%)	2.86
Soil sampling - management zone	8	3 (38%)	1 (12%)	1 (12%)	2 (25%)	1 (12%)	2.63
Remote sensing - aerial photos	3	1 (67%)	0	0	1 (33%)	0	2.00
Remote sensing - satellite images	2	2 (100%)	0	0	0	0	1.00
Soil survey maps	7	1 (14%)	3 (43%)	0	2 (29%)	1 (14%)	2.86
Mapping topography, slope, soil depth, etc.	2	2 (100%)	0	0	0	0	1.00
Plant tissue testing	1	--[d]	--	--	--	--	--
On-the-go sensing	2	2 (100%)	0	0	0	0	1.00
Variable rate nitrogen application	5	1 (20%)	0	0	2 (40%)	2 (40%)	3.80
Variable rate phosphorous and potassium application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate lime application	3	2 (67%)	1 (33%)	0	0	0	1.33
Variable rate seed application	2	0	1 (50%)	0	0	1 (50%)	3.50
Variable rate growth regulator application	3	1 (33%)	0	0	1 (33%)	1 (33%)	3.33
Variable rate defoliant application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate fungicide application	1	--	--	--	--	--	--
Variable rate herbicide application	3	1 (33%)	0	0	0	2 (67%)	3.67
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 16. Importance of trade shows as a source of information in learning about the precision farming technologies reported by Tennessee 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	6	1 (17%)[c]	1 (17%)	0	2 (33%)	2 (33%)	3.50
Yield monitoring - without GPS	4	3 (75%)	0	1 (25%)	0	0	1.50
Yield monitoring - without a yield monitor	3	2 (67%)	1 (33%)	0	0	0	1.33
Soil sampling - grid	6	3 (50%)	2 (33%)	0	1 (17%)	0	1.83
Soil sampling - management zone	7	4 (57%)	1 (14%)	0	1 (14%)	1 (14%)	2.14
Remote sensing - aerial photos	3	2 (67%)	0	0	1 (33%)	0	2.00
Remote sensing - satellite images		--[d]	--	--	--	--	--
Soil survey maps	6	4 (67%)	1 (17%)	0	1 (17%)	0	1.67
Mapping topography, slope, soil depth, etc.	2	2 (100%)	0	0	0	0	1.00
Plant tissue testing	1	--	--	--	--	--	--
On-the-go sensing	2	2 (100%)	0	0	0	0	1.00
Variable rate nitrogen application	5	3 (60%)	0	0	1 (20%)	1 (20%)	2.40
Variable rate phosphorous and potassium application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate lime application	3	3 (100%)	0	0	0	0	1.00
Variable rate seed application	2	2 (100%)	0	0	0	0	1.00
Variable rate growth regulator application	3	2 (67%)	0	0	1 (33%)	0	2.00
Variable rate defoliant application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate fungicide application	1	--	--	--	--	--	--
Variable rate herbicide application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 17. Importance of the Internet as a source of information in learning about the precision farming technologies reported by Tennessee 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	4	1 (25%)[c]	1 (25%)	2 (50%)	0	0	2.25
Yield monitoring - without GPS	4	2 (50%)	1 (25%)	1 (25%)	0	0	1.75
Yield monitoring - without a yield monitor	3	2 (67%)	1 (33%)	0	0	0	1.33
Soil sampling - grid	5	2 (40%)	2 (40%)	0	1 (20%)	0	2.00
Soil sampling - management zone	5	3 (60%)	1 (20%)	1 (20%)	0	0	1.60
Remote sensing - aerial photos	3	1 (33%)	0	1 (33%)	1 (33%)	0	2.67
Remote sensing - satellite images	2	1 (50%)	0	1 (50%)	0	0	2.00
Soil survey maps	5	3 (60%)	0	1 (20%)	1 (20%)	0	2.00
Mapping topography, slope, soil depth, etc.	2	1 (50%)	0	1 (50%)	0	0	2.00
Plant tissue testing	1	--[d]	--	--	--	--	--
On-the-go sensing	2	2 (100%)	0	0	0	0	1.00
Variable rate nitrogen application	5	2 (40%)	0	1 (20%)	1(20%)	1 (20%)	2.80
Variable rate phosphorous and potassium application	3	1 (33%)	0	0	1 (33%)	1 (33%)	3.33
Variable rate lime application	3	2 (67%)	0	0	1 (33%)	0	2.00
Variable rate seed application	2	1 (50%)	1 (50%)	0	0	0	1.50
Variable rate growth regulator application	3	2 (67%)	0	1 (33%)	0	0	1.67
Variable rate defoliant application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate fungicide application	1	--	--	--	--	--	--
Variable rate herbicide application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 18. Importance of the news media as a sources of information in learning about the precision farming technologies reported by Tennessee 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	4	2 (50%)[c]	2 (50%)	0	0	0	1.50
Yield monitoring - without GPS	4	2 (50%)	1 (25%)	1 (25%)	0	0	1.75
Yield monitoring - without a yield monitor	3	2 (67%)	1 (33%)	0	0	0	1.33
Soil sampling – grid	6	2 (33%)	2 (33%)	0	2 (33%)	0	2.33
Soil sampling – management zone	6	3 (50%)	0	1 (17%)	1 (17%)	1 (17%)	2.50
Remote sensing - aerial photos	3	1 (33%)	0	0	2 (67%)	0	3.00
Remote sensing - satellite images	2	1 (50%)	0	0	1 (50%)	0	2.50
Soil survey maps	6	4 (67%)	1 (17%)	0	1 (17%)	0	1.67
Mapping topography, slope, soil depth, etc.	2	2 (100%)	0	0	0	0	1.00
Plant tissue testing	1	--[d]	--	--	--	--	--
On-the-go sensing	2	2 (100%)	0	0	0	0	1.00
Variable rate nitrogen application	5	1 (20%)	0	0	2 (40%)	2 (40%)	3.80
Variable rate phosphorous and potassium application	3	1 (33%)	0	0	1(33%)	1 (33%)	3.33
Variable rate lime application	2	1 (50%)	0	1 (50%)	0	0	2.00
Variable rate seed application	2	2 (100%)	0	0	0	0	1.00
Variable rate growth regulator application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate defoliant application	3	2 (67%)	0	0	0	1 (33%)	2.33
Variable rate fungicide application	1	--	--	--	--	--	--
Variable rate herbicide application	3	1 (33%)	0	1 (33%)	0	1 (33%)	3.00
Variable rate insecticide application	1	--	--	--	--	--	--
Variable rate irrigation	1	--	--	--	--	--	--

[a] Survey question 13. [b] Level of importance ranges from not helpful (1) to very helpful (5). [c] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [d] Not reported to avoid disclosure.

Table 19. Degree of helpfulness assigned to information sources in learning about precision farming technologies reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey[a]

Source	Average Level of Helpfulness[b]
Extension/ Universities	3.50
Farm Dealers	3.24
Crop Consultants	3.06
Other Farmers	2.90
News and Media	2.24
Internet	2.07
Trade Shows	1.98

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

Table 20. Tennessee cotton farmers reporting the use of precision farming services - 2001 Southern Precision Farming Survey[a]

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 the farm?	36	19 (53%)[b]	17 (47%)

[a] Survey question 14. [a] Number in parenthesis indicate the percentage of respondents who gave the associated answer.

Table 21. Management and technical advice usage reported by Tennessee 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	2 (67%)[b]	1 (33%)	2.50	2 (100%)	0
Yield monitoring – without GPS	1 (50%)	1 (50%)	3.50	--[c]	--
Yield monitoring – without a yield monitor	1 (50%)	1 (50%)	4.00	--	--
Soil sampling – grid	9 (90%)	1 (10%)	3.44	9 (100%)	0
Soil sampling – management zone	4 (80%)	2 (20%)	1.00	2 (100%)	0
Remote sensing – aerial photos	1 (50%)	1 (50%)	4.00	--	--
Remote sensing – satellite images	0	2 (100%)	--	NR[d]	NR
Soil survey maps	3 (75%)	1 (25%)	1.25	1 (50%)	1 (50%)
Mapping topography, slope, soil depth, etc.	2 (67%)	1 (33%)	1.50	--	--
Plant tissue testing	0	2 (100%)	NR	NR	NR
On-the-go sensing	1 (50%)	1 (50%)	2.00	--	--
Variable rate nitrogen application	3 (75%)	1 (25%)	0	2 (100%)	0
Variable rate phosphorous and potassium application	4 (80%)	1 (20%)	0	4 (100%)	0
Variable rate lime application	5 (83%)	1 (17%)	1.67	6 (100%)	0
Variable rate seed application	1 (50%)	1 (50%)	NR	NR	NR
Variable rate growth regulator application	2 (67%)	1 (33%)	0	--	--
Variable rate defoliant application	2 (67%)	1 (33%)	3.00	--	--
Variable rate fungicide application	1 (50%)	1 (50%)	NR	NR	NR
Variable rate herbicide application	1 (50%)	1 (50%)	NR	NR	NR
Variable rate insecticide application	1 (50%)	1 (50%)	NR	NR	NR
Variable rate irrigation	--	--	NR	NR	NR

[a] Survey question 15. [b] Number in parenthesis indicate the percentage of respondents who gave the associated answer. [c] Not reported to avoid disclosure. [d] No response to the question.

Table 22. Custom services hired by responding Tennessee 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	--[b]	--	--	--	--
Yield monitoring - without GPS	NR[c]	NR	NR	NR	NR
Yield monitoring - without a yield monitor	NR	NR	NR	NR	NR
Soil sampling – grid	9 (90%)[d]	1 (10%)	4.11	8 (100%)	0
Soil sampling – management zone	1 (50%)	1 (50%)	1.00	2 (100%)	0
Remote sensing - aerial photos	NR	NR	NR	NR	NR
Remote sensing - satellite images	--	--	NR	NR	NR
Soil survey maps	--	--	--	NR	NR
Mapping topography, slope, soil depth, etc.	NR	NR	NR	NR	NR
Plant tissue testing	--	--	NR	NR	NR
On-the-go sensing	NR	NR	NR	NR	NR
Variable rate nitrogen application	2 (100%)	0	3.00	2 (100%)	0
Variable rate phosphorous and potassium application	5 (83%)	1 (17%)	4.00	4 (100%)	0
Variable rate lime application	7 (88%)	1 (12%)	4.17	7 (100%)	0
Variable rate seed application	--	--	--	--	--
Variable rate growth regulator application	1 (50%)	1 (50%)	1.00	2 (100%)	0
Variable rate defoliant application	NR	NR	NR	NR	NR
Variable rate fungicide application	--	--	--	NR	NR
Variable rate herbicide application	–	--	--	--	--
Variable rate insecticide application	--	--	NR	NR	NR
Variable rate irrigation	--	--	NR	NR	NR

[a] Survey question 15. [b] Not reported to avoid disclosure. [c] No response to the question. [d] Number in parenthesis indicate the percentage of respondents who gave the associated answer.

Table 23. Perceived profitability of precision farming and environmental benefit experienced by adopting Tennessee cotton farmers - 2001 Southern Precision Farming Survey

Survey Question	Number of Responses	Yes	No
Was precision farming profitable on your fields? [a]	27	19 (70%)[b]	8 (30%)
Have you experienced any improvements in environmental quality as a result of precision farming? [c]	26	8 (31%)	18 (69%)

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

Table 24. Opinions regarding the future profitability of precision farming reported by Tennessee 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
	88 (68%)[b]	41 (32%)	23 (85%)	4 (15%)	65 (64%)	37 (36%)
If you believe it would be profitable, would you prefer to own or rent your equipment? [c]	Own	Rent	Own	Rent	Own	Rent
	57 (59%)	40 (41%)	14 (61%)	9 (39%)	43 (58%)	31 (42%)

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

Table 25. Importance of precision farming five years from now reported by Tennessee 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	131	13 (10%)[c]	12 (9%)	28 (21%)	42 (32%)	36 (27%)	3.58
Adopters	29	1 (3%)	3 (10%)	5 (17%)	8 (28%)	12 (41%)	3.93
Non-adopters	102	12 (12%)	9 (9%)	23 (23%)	34 (33%)	24 (24%)	3.48
Corn							
All	103	11 (11%)	10 (10%)	26 (25%)	34 (33%)	22 (21%)	3.45
Adopters	25	3 (12%)	2 (8%)	5 (20%)	7 (28%)	8 (32%)	3.60
Non-adopters	78	8 (10%)	8 (10%)	21 (27%)	27 (35%)	14 (18%)	3.40
Soybeans							
All	112	17 (15%)	22 (20%)	34 (30%)	26 (23%)	13 (12%)	2.96
Adopters	26	3 (12%)	3 (12%)	11 (42%)	6 (23%)	3 (12%)	3.12
Non-adopters	86	14 (16%)	19 (22%)	23 (27%)	20 (23%)	10 (12%)	2.92
Wheat							
All	90	8 (9%)	19 (21%)	26 (29%)	24 (27%)	13 (14%)	3.17
Adopters	22	2 (9%)	3 (14%)	8 (36%)	4 (18%)	5 (23%)	3.32
Non-adopters	68	6 (9%)	16 (24%)	18 (26%)	20 (29%)	8 (12%)	3.12

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

Table 26. Estimates of the typical purchase price for a cotton yield monitoring system with GPS[a] reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey[b]

Group	Number of Responses	Average	Standard Deviation	Minimum	Maximum
All	51	$6,925	$3,730	$900	$15,000
Adopters	10	$7,200	$2,563	$4,000	$12,000
Non-adopters	41	6,857	3,986	900	15,000

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

Table 27. Ownership of cotton pickers and intentions to purchase or lease a new cotton picker reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey

Response	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	125 (85%)[c]	27 (93%)	98 (83%)	12 (8%)	3 (11%)	9 (8%)
No	22 (15%)	2 (7%)	20 (17%)	133 (92%)	25 (89%)	108 (92%)
4-row cotton picker	87 (90%)	21 (88%)	66 (90%)	7 (50%)	0	7 (64%)
5-row cotton picker	4 (4%)	0	4 (6%)	1 (7%)	0	1 (9%)
6-row cotton picker	6 (6%)	3 (12%)	3 (4%)	6 (43%)	3 (100%)	3 (27%)

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

Table 28. Respondents' willingness to purchase a yield monitoring system with a global positioning system for their 4 or 5-row cotton pickers at a specified dollar amount reported by Tennessee 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	16	3 (19%)[b]	5 (31%)	5 (31%)	3 (19%)
Adopters	4	2 (50%)	0	2 (50%)	0
Non-adopters	12	1 (8%)	5 (42%)	3 (25%)	3 (25%)
$6,000					
All	21	5 (24%)	11 (52%)	3 (14%)	2 (10%)
Adopters	6	2 (33%)	4 (67%)	0	0
Non-adopters	15	3 (20%)	7 (47%)	3 (20%)	2 (13%)
$7,500					
All	22	2 (9%)	11 (50%)	3 (14%)	6 (27%)
Adopters	3	1 (33%)	1 (33%)	1 (33%)	0
Non-adopters	19	1 (5%)	10 (53%)	2 (11%)	6 (32%)
$9,000					
All	19	1 (5%)	7 (37%)	5 (26%)	6 (32%)
Adopters	5	1 (20%)	1 (20%)	1 (20%)	2 (40%)
Non-adopters	14	0	6 (43%)	4 (29%)	4 (29%)
$10,500					
All	17	0	13 (76%)	4 (24%)	0
Adopters	3	0	3 (100%)	0	0
Non-adopters	14	0	10 (71%)	4 (29%)	0
$12,000					
All	22	2 (9%)	13 (59%)	4 (18%)	3 (14%)
Adopters	5	0	4 (80%)	1 (20%)	0
Non-adopters	17	2 (12%)	9 (53%)	3 (18%)	3 (18%)

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

Table 29. Respondents' willingness to purchase an optional yield monitoring system for an additional cost when purchasing or leasing a new 4, 5, or 6-row cotton picker reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey[a]

Purchase cost 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/ lease a new picker
$4,500					
All	18	4 (22%)[b]	4 (22%)	2 (11%)	8 (44%)
Adopters	4	3 (75%)	0	1 (25%)	0
Non-adopters	14	1 (7%)	4 (29%)	1 (7%)	8 (57%)
$6,000					
All	23	7 (30%)	8 (35%)	4 (17%)	4 (17%)
Adopters	6	2 (33%)	3 (50%)	0	1 (17%)
Non-adopters	17	5 (29%)	5 (29%)	4 (24%)	3 (18%)
$7,500					
All	23	0	4 (17%)	5 (22%)	14 (61%)
Adopters	3	0	0	1 (33%)	2 (67%)
Non-adopters	20	0	4 (20%)	4 (20%)	12 (60%)
$9,000					
All	21	4 (19%)	3 (14%)	4 (19%)	10 (48%)
Adopters	5	2 (40%)	0	0	3 (60%)
Non-adopters	16	2 (12%)	3 (19%)	4 (25%)	7 (44%)
$10,500					
All	20	1 (5%)	11 (55%)	4 (20%)	4 (20%)
Adopters	3	0	1 (33%)	2 (67%)	0
Non-adopters	17	1 (6%)	10 (59%)	2 (12%)	4 (24%)
$12,000					
All	26	3 (12%)	6 (23%)	8 (30%)	9 (35%)
Adopters	5	1 (20%)	2 (40%)	1 (20%)	1 (20%)
Non-adopters	21	2 (10%)	4 (19%)	7 (33%)	8 (38%)

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

Table 30. Year 2000 farm size and tenure characteristics reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey

Item	Number of Responses	Average	Standard Deviation	Minimum	Maximum
Acres owned [a]					
All	143	624	2424	0	22,050
Adopters	26	624	981	0	5000
Non-adopters	117	624	2643	0	22,050
Acres share rented [a]					
All	143	659	835	0	3856
Adopters	26	975	939	0	3500
Non-adopters	117	589	798	0	3856
Typical length of share rental agreement (years) [b]					
All	104	3	3	0	20
Adopters	26	3	2	0	10
Non-adopters	78	3	3	0	20
Acres cash rented [a]					
All	143	425	715	0	4409
Adopters	26	737	1071	0	4000
Non-adopters	117	336	593	0	4409
Typical length of cash rental agreement (years) [c]					
All	102	2	1	0	7
Adopters	21	2	1	1	5
Non-adopters	81	2	2	0	7

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

Table 31. Planted acres and estimated crop yields for 1999 reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey[a]

Crop	All		Adopters		Non-adopters	
	Planted acres	Yield	Planted acres	Yield	Planted acres	Yield
Cotton		(lb/acre)		(lb/acre)		(lb/acre)
Average	693	532	1087	553	599	526
Standard Deviation	744	126	1084	105	605	130
Minimum	8	57	25	350	8	57
Maximum	4800	900	4800	750	3200	900
Number of Responses	139	129	27	25	112	104
Corn		(bu/acre)		(bu/acre)		(bu/acre)
Average	342	96	525	95	283	96
Standard Deviation	329	24	411	28	274	23
Minimum	9	25	40	25	9	40
Maximum	1400	150	1200	150	1400	150
Number of Responses	70	68	17	16	53	52
Soybeans		(bu/acre)		(bu/acre)		(bu/acre)
Average	558	19	808	22	495	18
Standard Deviation	673	7	715	6	573	7
Minimum	12	8	125	10	12	8
Maximum	3081	39	2690	30	3081	39
Number of Responses	110	103	22	19	88	84
Wheat		(bu/acre)		(bu/acre)		(bu/acre)
Average	217	50	264	51	202	50
Standard Deviation	206	12	225	10	201	13
Minimum	10	20	14	30	10	20
Maximum	1100	80	600	63	1100	80
Number of Responses	52	51	13	13	39	38

[a] Survey question 28.

Table 32. Planted acres and estimated crop yields for 2000 reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey[a]

Crop	All		Adopters		Non-adopters	
	Planted acres	Yield	Planted acres	Yield	Planted acres	Yield
Cotton		(lb/acre)		(lb/acre)		(lb/acre)
Average	753	623	1202	652	638	615
Standard Deviation	794	143	1113	126	649	147
Minimum	9	108	25	400	9	108
Maximum	4800	1015	4800	1015	3200	920
Number of Responses	133	125	27	26	106	99
Corn		(bu/acre)		(bu/acre)		(bu/acre)
Average	326	110	452	112	285	109
Standard Deviation	307	26	386	23	268	27
Minimum	8	45	12	70	8	45
Maximum	1500	173	1500	170	1400	173
Number of Responses	73	72	18	19	55	53
Soybeans		(bu/acre)		(bu/acre)		(bu/acre)
Average	572	21	783	22	514	21
Standard Deviation	608	8	688	8	576	7
Minimum	5	0	5	10	13	0
Maximum	2828	40	2500	40	2828	39
Number of Responses	103	99	22	21	81	78
Wheat		(bu/acre)		(bu/acre)		(bu/acre)
Average	237	61	284	64	219	60
Standard Deviation	223	12	254	13	210	12
Minimum	17	35	28	40	17	35
Maximum	1100	90	870	81	1100	90
Number of Responses	58	57	16	15	42	42

[a] Survey question 28.

Table 33. Annual average spatial yield variability of a typical field reported by Tennessee 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	(lb/acre)								
Average	454	488	444	642	682	631	817	870	801
Standard Deviation	124	95	130	117	80	124	153	102	162
Minimum	50	300	50	200	500	200	440	700	440
Maximum	750	700	750	968	850	968	1300	1000	1300
Responses	101	23	78	103	23	80	100	23	77
Corn	(bu/acre)								
Average	77	79	76	113	113	113	144	151	142
Standard Deviation	24	24	25	23	23	23	27	34	24
Minimum	10	45	10	40	75	40	90	110	90
Maximum	137	130	137	170	150	170	225	225	200
Responses	60	16	44	61	16	45	59	15	44
Soybeans	(bu/acre)								
Average	17	19	16	29	32	29	41	45	40
Standard Deviation	8	8	8	7	6	7	10	9	10
Minimum	0	5	0	10	20	10	20	30	20
Maximum	39	36	39	42	42	42	60	60	60
Responses	76	17	59	78	18	60	77	17	60
Wheat	(bu/acre)								
Average	38	38	38	55	56	55	73	79	71
Standard Deviation	11	13	11	9	13	7	14	16	14
Minimum	10	10	10	30	30	35	48	60	48
Maximum	70	50	70	73	73	70	110	110	110
Responses	45	10	35	45	11	34	45	10	35

[a] Survey question 29.

Table 34. Number of Tennessee cotton farmers that 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	146	49 (34%)[b]	97 (66%)
Adopters	28	10 (36%)	18 (64%)
Non-adopters	118	39 (33%)	79 (67%)
Do you apply manure to your fields?			
All	92	7 (8%)	85 (92%)
Adopters	16	0	16 (100%)
Non-adopters	76	7 (9%)	69 (91%)

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

Table 35. Average age and number of years farming reported by the primary decision-maker for Tennessee cotton farms – 2001 Southern Precision Farming Survey

Item	Number of Responses	Average	Minimum	Maximum
		----------Number of Years----------		
Age [a]				
All	148	50	24	82
Adopters	29	47	29	63
Non-adopters	119	50	24	82
Years of farming [b]				
All	140	27	4	76
Adopters	29	26	10	63
Non-adopters	111	28	4	76

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

Table 36. Education level reported by Tennessee cotton farmers - 2001 Southern Precision Farming Survey[a]

Item	Did you complete high school?		If yes, how many years did you go to college?		
	Yes	No	Average	Minimum	Maximum
All	138 (95%)[b]	7 (5%)	2	0	7
Adopters	28 (97%)	1 (3%)	2	0	5
Non-adopters	110 (95%)	6 (5%)	2	0	7

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

Table 37. Computer ownership and usage as reported by the primary decision maker for Tennessee cotton farmers - 2001 Southern Precision Farming Survey[a]

Item	All		Adopters		Non-adopters	
	Yes	No	Yes	No	Yes	No
Do you own a computer?	108 (74%)[b]	36 (26%)	24 (83%)	5 (17%)	84 (72%)	32 (28%)
Do you use it for farm management?	69 (59%)	48 (41%)	18 (75%)	6 (25%)	51 (55%)	42 (45%)

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

Table 38. Estimated total household income in 2000 for all respondents from farm and non-farm sources reported by Tennessee 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	Percent
Less than $50,000	32 (71%)[d]	13 (29%)	48 (34%)[e]	40	67
$50,000 to $99,999	28 (60%)	19 (40%)	48 (34%)	48	53
$100,000 to $149,999	8 (50%)	8 (50%)	17 (12%)	17	60
$150,000 to $199,999	4 (100%)	0	4 (3%)	4	96
$200,000 to $500,000	12 (100%)	0	12 (9%)	11	73
$500,000 or greater	10 (91%)	1 (9%)	11 (8%)	11	84

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

Table 39. Estimated total household income in 2000 for responding adopters from farm and non-farm sources reported by Tennessee 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	Percent
Less than $50,000	6 (100%)[d]	0	6 (21%)[e]	6	85
$50,000 to $99,999	7 (70%)	3 (30%)	10 (36%)	10	72
$100,000 to $149,999	4 (100%)	0	4 (14%)	4	78
$150,000 to $199,999	0	0	0	0	0
$200,000 to $500,000	4 (100%)	0	4 (14%)	4	79
$500,000 or greater	4 (100%)	0	4 (14%)	4	96

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

Table 40. Estimated total household income in 2000 for responding non-adopters from farm and non-farm sources reported by Tennessee 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	Percent
Less than $50,000	26 (76%)[d]	13 (33%)	42 (38%)[e]	34	63
$50,000 to $99,999	21 (57%)	16 (43%)	38 (34%)	38	49
$100,000 to $149,999	4 (33%)	8 (67%)	13 (12%)	13	54
$150,000 to $199,999	4 (100%)	0	4 (4%)	4	96
$200,000 to $500,000	8 (100%)	0	8 (7%)	7	69
$500,000 or greater	6 (100%)	0	7 (6%)	7	77

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

Table 41. Farm planning goals reported by Tennessee 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.	70 (52%)[b]	17 (61%)	53 (50%)
I want to expand the size of operation through acquiring additional resources.	18 (13%)	7 (25%)	11 (10%)
I am thinking about retirement and transfer of farm to the next generation.	33 (24%)	4 (14%)	29 (27%)
I am considering selling the farm and moving on to a different career.	14 (10%)	0	14 (13%)

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