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Investigating the Adoption of Auto-Steer by Row-Crop Farmers in Mississippi

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Investigating the adoption of auto-steer by row-crop farmers in Mississippi

By

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Investigating the adoption of auto-steer by farmers in Mississippi

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The purpose of this research is to identify socio-economic factors which may influence the adoption of auto-steer technologies by row crop farmers in Mississippi. The variables of geographic location, size of farm, age of the farmer, and educational level of the farmer were analyzed using a binary logistic regression analysis to determine if those variables could be used as predictors in the farmer's adoption of auto-steer. Analysis revealed that the size of the farm and the age of the farmer are both statistically significant predictors of the probability of a farmer adopting auto-steer in the state of Mississippi. Geographic location and level of education were both included in the model but failed to indicate significant predictive ability. Among farmers who adopted auto-steer respondents ranked the importance of saving time and profitability as the most important and second most important factor in their decision to adopt auto-steer. Future research involving precision agriculture technologies should also include advances in the fields of beef production, forestry, and aquaculture. These can provide helpful insight into the reasons why a producer would adopt a particular precision agriculture technology.

DEDICATION

This research is dedicated to the farmers of Mississippi and to the Mississippi State University Extension Service.

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CHAPTER I

INTRODUCTION

Farming is a way of life for many in Mississippi. According to the Mississippi Farm Bureau Federation (2017), there are approximately 35,800 farms in Mississippi. These farms account for 22% of the state's total income and 29% of the state's employment force according to the Mississippi Farm Bureau Federation (2017).

Not only is farming a way of life, but it is also a business enterprise that must be managed in a way that it is profitable for the farmer. Management decisions made by the farmer have direct effects on the financial health of the farm. As with any business, there are numerous opportunities for producers to adjust their methods of management and production in order to realize a more substantial profit. One such opportunity is the incorporation of new technologies to improve the operation. Studies regarding the use of precision agriculture technologies have shown that they consistently increase net returns (Smith, Dhuyvetter, Kastens, Kastens, and Smith, 2013; Shockley, Dillon, Strombaugh, and Shearer, 2012; Shockley, Dillon and Strombaugh, 2011).

Statement of the Problem

Understanding the needs and motivations of farmers is key to being able to design and implement educational programs that prove beneficial for them in their farming operations. According to Castle, Luben, and Luck (2016), an increasing world population and volatile commodity prices have made it necessary for producers to become more efficient in their operations. In response to conditions, such as those just mentioned, precision agriculture technologies are being developed to assist farmers by focusing on production and economic efficiency. According to the National Research Council (1997), precision agriculture can be defined as a management strategy that uses information technology to bring data from multiple sources to bear on decisions associated with crop production. Understanding why farmers adopt or don't adopt a precision agriculture technology can aid the Extension Service professionals in developing or modifying educational programs that might influence the farmer's decisions to utilize these technologies. One such precision agriculture technology is called auto-steer. According to D'Antoni, Mishra, and Joo (2012), auto-steer is a global positioning system based guidance technology that allows the farmer to focus on monitoring the operation of the implement instead of having to worry about steering the equipment. They also stated that research concerning the adoption of auto-steer, has failed to investigate the farmer's perceptions of concerning this technology. Auto-steer became commercially available in 1997 through combined efforts of the precision farming group which was developed by John Deere© in 1994. At present, auto-steer can be purchased as a kit that can be installed on existing equipment or equipment can be purchased with an auto-steer system already in place.

Background

Within Mississippi, there has been little research that specifically investigated the reasoning behind the adoption or non-adoption of a specific agriculture technology. Mooney et al. (2010) conducted a study that encompasses twelve southern states, including Mississippi. Their study examined precision farming by cotton producers only.

Results indicated that nearly two-thirds (63%) of respondents had adopted a precision agriculture technology. Within their study, respondents were counted as adopters if they reported having used a yield monitor, soil maps, aerial photography, grid sampling, or satellite imagery.

Auto-steer use among row crop farmers has not been specifically examined. As mentioned previously, auto-steer allows the producer to concentrate on implement operation and less on steering the equipment. Auto-steer became commercially available in late 1997 through John Deere©. This system was called auto-trac. Since becoming available, auto-steer systems can be included on purchased equipment or as kits that can be installed on equipment after purchase.

Purpose of Study

The purpose of this research was to determine the relationships between selected farm and farmer characteristics and the adoption of auto-steer technologies by row-crop farmers in Mississippi. This research will attempt to determine if the selected variables can be used as predictors of whether or not a farm operator is going to adopt the precision agriculture technology called auto-steer. This information will then be used to improve the efficiency and impact of educational programming efforts targeted to row crop farmers by extension. Research indicates that adoption of auto-steer is a sound investment (Shockley et al., 2011), thus the study will examine what might pre-dispose a producer to adopt or not to adopt. An understanding of the characteristics that would indicate adoption of auto-steer could help guide educational efforts offered through Mississippi State University and any Extension Service.

Farmers have many resources they can call upon for assistance. One of the primary agencies that assists farmers in Mississippi is the Mississippi State University Extension Service. Extension agents can play a role in the adoption of an agricultural innovation. Agents in each county across the state advise and work hand in hand with farmers in order to help them with management decisions. The Extension Service is tasked with providing unbiased, research-based information that is reliable and usable by farmers. This information is used by farmers to assist them in making decisions on their farm which include adoption of a new technology.

Funding changes throughout the years have mandated that Extension utilize its resources in a more efficient manner in order to provide effective quality services to farmers. Within the agriculture and natural resource division, this equates to focusing attention on topics that may directly assist farmers. Gathering information about farmers in the state should aid in determining whether educational programming provided by the Mississippi State Extension Service will be effective. This is directly related to why it is important to know the differences and characteristics of who adopts a technological innovation such as auto-steer and who doesn't. Furthermore, studying the adoption characteristics of these farmers, the Extension service will be able to better service their needs.

There are farming operations located across the entire state of Mississippi. These farms fall into two different categories based upon geographical locations, which are the Delta and the Hills (USDA NASS, 2017). According to the USDA National Agriculture Statistics Service (2017), eighteen counties are located in the Delta. These include Bolivar, Carroll, Coahoma, Desoto, Holmes, Humphreys, Issaquena, Leflore, Panola, Quitman, Sharkey, Sunflower, Tallahatchie, Tate, Tunica, Warren, Washington, and Yazoo. The Delta area is located in the northwest part of the state between the Mississippi and the Yazoo rivers. The remaining counties in the state are considered Hill counties. Understanding auto-steer adoption and diffusion by producers within and between the two different regions might allow the Mississippi State University Extension Service to adjust how it delivers information in order to increase the probability of adoption and decrease the time it takes producers to decide to adopt. Determining if there are differences between adopters in the Delta counties and those in the Hill counties might allow even further adjustments as to what types of programs are offered concerning farm profitability and efficiency.

Another goal of the study was to examine characteristics of row-crop farmers that can be used as predictors of auto-steer. These will include the geographic location of the farm, the size of the farm, the age of the farmer, and the educational level of the farmer. The study also examined the reasons why a farmer chose to adopt auto-steer.

For the purpose of this study, auto-steer was selected because it can save money, save time, reduce operator errors (Schimmelpfennig, 2016), and is a sound investment (Shockley et al., 2011).

Research Objectives

1. Describe the characteristics of row-crop farming operations in Mississippi with regard to geographical location, size of the farm, types of crops grown, age of the farmer, and educational level attained by the farmer.

2. Determine the interaction between the use or non-use of auto-steer and the variables of: geographical location, size of the farm, age of the farmer, crop mix and educational level attained by the farmer.
3. Identify and rate the reasons underlying the decisions to adopt auto-steer.

Significance of the Study

Research has shown that the adoption of auto-steer is a sound investment option (Shockley et al., 2011). Other precision agriculture technologies have also been shown to consistently increase net returns (Smith, et al, 2013, Shockley et al, 2012; Shockley et al, 2011). These four studies provide justification for the use of auto-steer but some farmers have not adopted. The goal of this study is to provide insight into what characteristics might make a producer more willing to adopt auto-steer.

D'Antoni, Mishra, and Joo (2012) remarked that research has failed to investigate three important factors in determining the adoption of auto-steer technology. The first factor is the farmers' perceptions of precision agriculture technology in general. The second factor is the importance of cost savings which has been shown to increase net returns (Smith et al, 2013; Shockely et al., 2011) and lastly, whether or not the farmers perceived auto-steer as profitable.

It is important to realize that farmers may have different perceptions about the benefits of auto-steer. This can mean differences between states or regions of the country. Castle et al. (2016) evaluated the factors that influence the adoption of precision agriculture technologies by farmers in Nebraska. They found that that the number of row crop acres in the operation and the usage of a cell phone with internet access were both statistically significant and affected the number of precision technologies adopted. The result was as expected with regard to number of row crop acres in the farming operation. The larger farmers were more likely to be able to afford the investment in the technology (Castle et al, 2016). The producers in this study that were not using a cell phone with internet access was found to have a negative effect on the number of precision agriculture technologies adopted (Castle et al, 2016).

Data could be segregated into the two separate regions of Mississippi which would include the Delta and the Hills. This information could prove to be beneficial determining characteristics that farmers possess that may influence their likelihood to adopt. This information could further be used to design and implement training programs to educate farmers about auto-steer.

Limitations

When performing any type of research study, there are limitations. The following limitations should be considered when reading or replicating this study:

1. There is a possible sample size limitation since the survey was distributed using email. There are still some producers who do not have an email address which indicates that the surveys might not have reached all potential respondents.
2. The survey was sent to Mississippi producers only, therefore the results of this survey cannot be generalized across state lines.

3. Self-reported data such as found in this study can rarely be independently verified and the following biases are possible: selective memory, telescoping, attribution, and exaggerations (USC Libraries, n.d.).
4. Researcher-created instruments can create bias (Morrison, 2017).
5. The limited amount of previous research performed specifically on the use of auto-steer could be seen as a limitation (USC Libraries, n.d.).

Assumptions

The following assumptions were made prior to, and during, the completion of this study:

1. Participants answered all questions honestly and to the best of their knowledge and ability and understood each particular question.
2. Row-crop farmers who completed the survey instrument had farms in Mississippi.
3. Participants have a sincere interest in participating in the research and are not motivated by any other internal or external factors. Participation was completely voluntary and participants could stop answering questions in the instrument at any time.
4. The sample respondents in the study are representative of all farmers in Mississippi.

Definitions

Auto-steer: A global positioning system (GPS) based guidance technology that allows the farmer to focus on monitoring the operation of the implement instead of having to worry about steering the equipment (D'Antoni, Mishra, & Joo, 2012).

Delta: A geographical area located in the northwest part of the state of Mississippi between the Mississippi and the Yazoo rivers. The counties located within the Delta include Bolivar, Carroll, Coahoma, Desoto, Holmes, Humphreys, Issaquena, Leflore, Panola, Quitman, Sharkey, Sunflower, Tallahatchie, Tate, Tunica, Warren, Washington, and Yazoo (USDA NASS, 2012).

Diffusion: A special type of communication in which the messages are about a new idea (Rogers, 2003, pg. 6).

Early adopter: An adopter category that adopts an innovation after the innovators and are more part of the local social system as compared to innovators (Rogers, 2003, pg. 283).

Early majority: An adopter category that adopts new ideas just before the average member of a social system (Rogers, 2003, pg. 283).

GPS: Acronym for global positioning system. A global system of U.S. navigational satellites developed to provide precise positional and velocity data and global time synchronization for air, sea, and land travel (Alabama Cooperative Extension System, 2018).

Innovation: An idea, practice, or project that is perceived as new by an individual or another unit of adoption (Rogers, 2003).

Innovator: A person who is one of the first individuals to adopt an innovation and are active information seekers about new ideas (Rogers, 2003, pg. 22).

Laggard: An adopter category that represents those individuals who are the last in a social system to adopt an innovation (Rogers, 2003, pg. 284).

Late majority: An adopter category characterized by adopting new ideas just after the average member of a social system (Rogers, 2003, pg. 284).

Precision Agriculture: A management strategy that uses information technology to bring data from multiple sources to bear on decisions associated with crop production (National Research Council, 1997).

Smith-Lever Act: A United States federal law that established a system of cooperative extension services, connected to land-grant universities, in order to inform people about current developments in agriculture, home economics, public policy/government, leadership, 4-H, and economic development (7 U.S.C § 343, 1914).

USDA: United States Department of Agriculture. The purpose of the USDA is to provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management (United States Department of Agriculture, 2018).

VRT: Variable-rate technology (VRT) describes any technology which enables producers to vary the rate of crop inputs. VRT combines a variable-rate

(VR) control system with application equipment to apply inputs at a precise time and/or location to achieve site-specific application rates of inputs (Alabama Cooperative Extension System, 2018).

CHAPTER II

LITERATURE REVIEW

This review of literature provides insight into precision agriculture innovations and the adoption of those innovations by farmers. More specifically, the literature review illustrates the process of adoption and diffusion of a particular precision agriculture technology. Roger's (2003) principles of adoption and diffusion were applied to examine farmers' reasons for adopting a precision agriculture technology.

Precision Agriculture

Precision agriculture can play and has played an important role in agriculture in Mississippi. Mississippi Farm Bureau reported the 2017 farm-gate value of agriculture and forestry production for Mississippi was approximately $7.56 billion dollars, which represents 35,800 farms in the state (USDA Census of Agriculture, 2017). This is a decrease of 6 percent in the number of farms since the 2012 Census of Agriculture. Generally speaking, farm numbers have decreased while at the same time the average productivity per farm increased. This makes it all the more important that farmers be more efficient in their production practices in order to remain competitive. One of the many ways that farmers could accomplish this goal is through the use of precision agriculture.

Precision agriculture technology is a broad term that encompasses a wide array of innovations. According to the National Research Council (1997), precision agriculture could be defined as a management strategy that utilizes information technology to bring data from multiple sources to bear on decisions associated with crop production. This management strategy can also include a physical innovation that is utilized on the farm in order to increase production and aid the farmer in being more efficient. According to Shimmelpfennig (2016), precision agriculture technologies allow farm operators to fine tune their production practices, which can make them more efficient, as well as optimize their production capabilities. Studies dealing with specific precision agriculture technologies have shown that they consistently increase net returns (Smith et al, 2013; Shockely et al., 2011). In another study conducted by Schieffer and Dillon (2015), producers that were using precision agriculture technologies have the opportunity to reduce their environmental impacts as well as improve their productivity and increase their profits. A study conducted in Nebraska by Castle et al. (2016) found that tech savvy producers were more likely to adopt a precision agriculture technology. They also found that as the operator's age increased, they were less likely to adopt a precision agriculture technology.

In today's farming operations, producers have access to hundreds of types of precision agriculture innovations. One of the very first innovations developed was hybrid corn in 1928 (Stephenson, 2002). This was a physical innovation that the farmer could purchase and plant. Other precision agriculture innovations include yield monitors, which give the farmer information concerning how well their crop is producing; computer mapping, which shows the farmer what area of a field has been planted or sprayed; guidance systems, which let the farmer know precise real-time locations of equipment in the field and can physically drive a piece of equipment; and variable rate technology (VRT), which allows the farmer to vary farm inputs such as seed or fertilizer per acre (Schimmelpfennig, 2016).

Under the broad heading of precision agriculture technologies, one innovation in particular is called auto-steer. Auto-steer is a global positioning system (GPS) based guidance technology that allows the farmer to focus on monitoring the operation of the implement instead of having to worry about steering the equipment (D'Antoni, Mishra, & Joo, 2012). Research also indicates that the adoption of auto-steer is a sound investment (Shockley et al., 2011, D'Antoni et al., 2012). Lowenberg-DeBoer (1999) found that of all the studies concerning precision agriculture he reviewed, seventy-three percent of those found precision farming to be profitable and most producers had made only modest investments in precision agriculture.

Farm machinery can be manufactured with the auto-steer system in place or the system can be purchased and integrated into existing equipment. Auto-steer basically performs the task of driving based upon satellite uplink information. The accuracy of the auto-steer system can vary but routinely it is accurate to within a few inches.

According to Schimmelpfennig (2016), adopting GPS-guided or auto-steered combines or tractors can potentially reduce operator errors by determining precise field locations. Schimmelpfennig (2016) also stated that the use of auto-steer can compensate for operator fatigue which could limit how much work is done within a specified period of time. In an earlier study, Feder, Just, and Zilberman (1985), found that precision technologies, such as auto-steer, can benefit aging farm operators by reducing the amount physical demand on the operator during the farming process. In addition to this reduction in physical demand, auto-steer may reduce the skill level necessary to operate farm machinery (Griffin, Lowenberg-DeBoer, Peone, Payne, & Daberkow, 2004).

Schimmelpfennig (2016) also said that guidance systems may save money by reducing the costs associated with over and under applications of sprays and fertilizers and better align the seeding of field crop rows. This precise placement could amount to savings in not only fuel but also seed, fertilizer, and wear and tear on the equipment. Auto-steer also frees the operators from steering, thereby allowing them to potentially monitor several precision agriculture systems at once (Schimmelpfennig, 2016). Auto-steer eliminates human error, such as overlapping and skipping, which can lead to mis-application of pesticides, fertilizers, and seed (D'Antoni et al., 2012).

Rogers' Adoption Process

Using innovations is one of the many decisions that farmers have to make when dealing with their operation. Early work that sought to explain the how, why, and at what rate innovations and technology spread was published by Everett Rogers in 1962. His theory of Diffusion of Innovations stated that an innovation is an idea, practice, or project that is perceived as new by an individual or another unit of adoption (Rogers, 2003). Even if an innovation has been present for many years, if an individual perceives it as new to them, then it would still be considered an innovation. Understanding the risks and consequences of an innovation will have an impact on whether or not the farmer decides to implement an innovation. Rogers (2003) states that "Consequences are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation" (p. 30).

According to Rogers (2003), the process of deciding to use an innovation is referred to as the innovation-decision process. Generally speaking, it is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward the innovation, then to a decision to adopt or reject, followed by implementation of the decision, and finally confirmation of this decision. This process is characterized by five stages. These stages include knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003) (Figure 1).

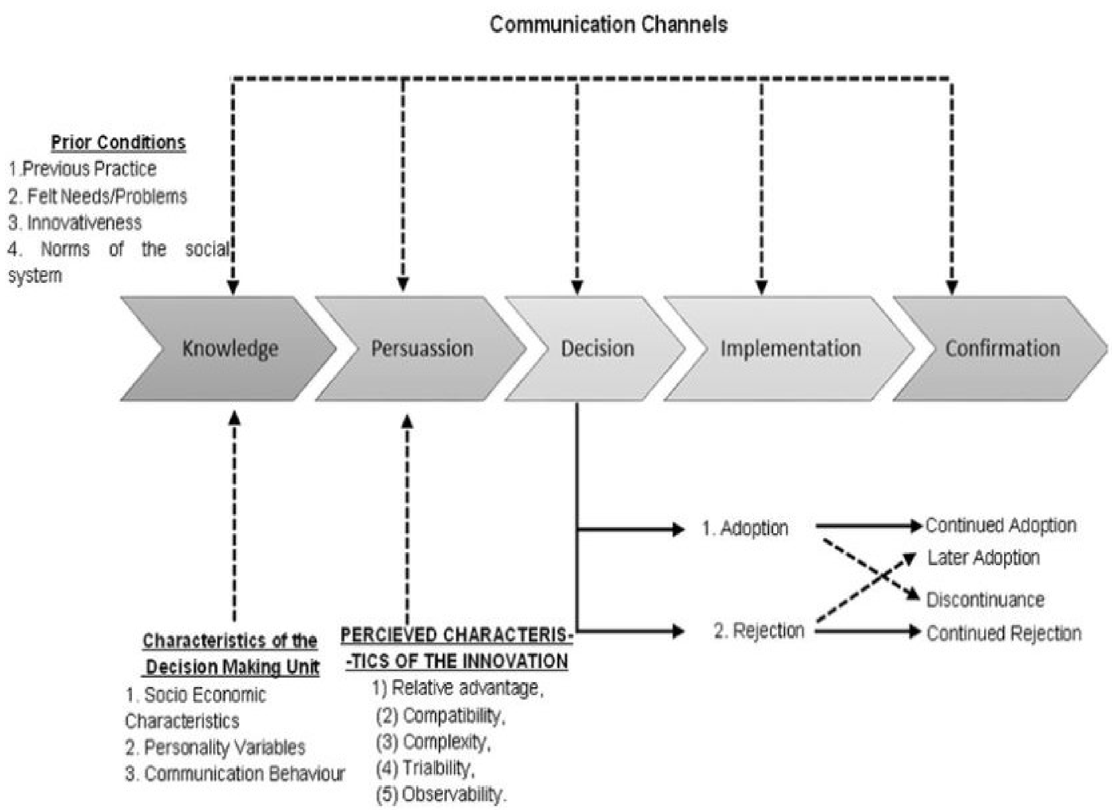

Figure 1 Rogers' Innovation-Decision Model

A model of Five Stages in the Innovation –Decision Process. Rogers, E.M. (2003). *Diffusion of innovations*. New York, NY: Free Press

During the knowledge stage, an individual learns about the existence of the innovation, and will seek information about the innovation (Rogers, 2003). Rogers (2003) determined that this is when the individual will attempt to understand what the innovation is and why it works the way it does.

Following the knowledge stage is the persuasion stage. During this stage the individual will have a negative or positive initial view towards the innovation. Rogers (2003) notes that the formation of an unfavorable or a favorable attitude toward an innovation does not always lead directly to adoption or rejection of the innovation. Furthermore, Rogers states that during this stage, knowledge is more cognitive in nature as opposed to being centered on feelings. This is important because until an individual knows about a new idea, they cannot begin to form an attitude toward it. During the persuasion stage, the individual also actively seeks out information regarding the innovation and decides what information they regard as credible as well as how they interpret it (Rogers, 2003).

The next stage of adoption that Rogers identifies is the decision stage. During this stage the individual will make a choice to adopt or reject the innovation (Rogers, 2003). He also notes that if the innovation has a partial trial basis, it is usually adopted more quickly due to the fact that individuals want to try the innovation in their own situation. According to Sahin (2006), this trial period can speed up the innovation decision process. During the decision process, Rogers (2003) points out that rejection is still a possibility. According to Rogers (2003), there are two types of rejection. The first is active rejection. This is when the individual will try an innovation and begin thinking about adopting it but decides to not adopt it at a later time. The second is termed passive rejection (Rogers, 2003). Passive rejection occurs when the individual will not think of adopting the innovation at all.

The implementation stage follows the decision stage. It is during this stage that the innovation is put into practice (Rogers, 2003). Rogers also points out that during this stage, uncertainty about the innovation can still be a problem. During the implementation stage, the individual might need assistance from a change agent and others to reduce the amount of uncertainty about any possible consequences (Rogers, 2003; Sahin, 2006). During the implementation stage, the individual might change or modify the innovation to better suit her or his needs. This process is referred to as re-invention (Rogers, 2003). It was first thought by researchers that re-invention did not occur or if it did it was considered a minimal and unusual activity. After further research, it was found that re-invention occurs quite regularly during the implementation stage (Rogers, 2003). Furthermore, Rogers (2003) states that during the implementation stage "the innovation loses its distinctive quality as the separate identity of the new idea disappears" (p. 180). Rogers (2003) considers this the point where the innovation decision process has terminated for many individuals.

The final stage in Rogers' adoption diffusion process is the confirmation stage. During this stage, the decision to accept has already been made and the individual is now seeking support for his or her decision to adopt (Rogers, 2003). According to Rogers (2003), the individual's decision can be reversed during this stage. The individual will also tend to seek affirmation that will support his or her decision as opposed to listening to negative messages. According to Sahin (2006), attitudes become crucial during the confirmation stage. Depending on the support for the adoption of the innovation and the attitude of the person adopting, later adoption or discontinuance can happen during this stage.

When considering the adoption of auto-steer by farmers in Mississippi, it is important to look at the entire process involved with adoption as well as the diffusion of the information associated with the innovation. A study conducted by Abadi Ghadim and Pannell (1999) presented a framework that outlined the adoption process as a multi-stage decision process involving information acquisition and learning by doing. This process suggested that learning leads to skill improvement, reduces uncertainty, and improves decision making.

Another consideration in the adoption of innovations according to Rogers is the communication channel. Communication is a process where participants can create and share information with others in order to reach what he defines as a mutual understanding (Rogers, 2003). This communication takes place through channels between sources. Effective communication is needed to insure that those involved understand all the aspects of the innovation in question. Rogers (2003) goes on to say that information about a new idea is not sought by individuals until they are aware that the new idea exists and when they know which channels of communication can provide information about the innovation. The importance of these channels of communication depends on the availability to the potential adopters.

Categories of Adopters

Adopters of precision agriculture technology fall into five categories as identified by Rogers (2003). These included innovators, early adopters, early majority, late majority, and laggards (Figure 2).

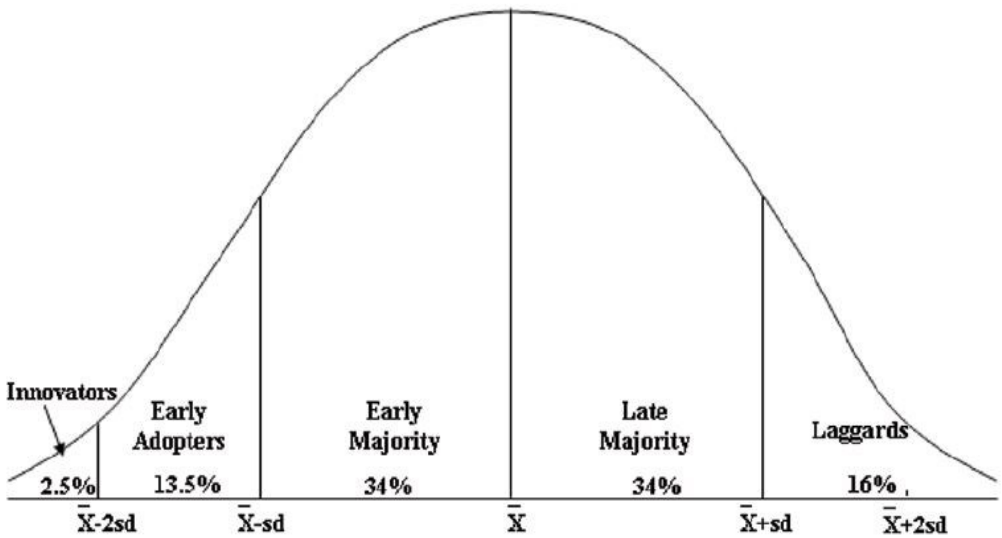

Figure 2 Rogers' diagram of the categories of adopters

Adopter categorization on the basis of innovativeness. Rogers, E.M. (2003). *Diffusion of innovations*. New York, NY: Free Press.

According to Rogers (2003), innovators are very venturous almost to the point of obsession and they are willing to experience new ideas. Rogers (2003) assumed that they would also be better prepared to cope with unprofitable and unsuccessful innovations as well as a level of uncertainty about the innovation. According to Rogers (2003), innovators might be viewed as being outside of the social system and possibly not respected by other members within that social system.

Early adopters on the other hand were a more integrated part of the social system. Rogers (2003) stated that early adopters were more limited within the boundaries of their social system and that they were more likely to hold leadership roles in their social system. This is in stark contrast to his definition of innovators. As leaders other members of their social system will come to them for advice and as Roger's points out, early adopters can decrease uncertainty about the innovation among their peer group.

The next group that Rogers (2003) identifies are the early majority. This particular group typically adopts new ideas just before the average member of society does. Rogers (2003) describes them, saying they do not possess the leadership roles that are often found amongst early adopters and they might deliberate for some time before completely adopting a new idea. Rogers (2003) further states they are deliberate in their decision to adopt an innovation but they are neither the first nor the last.

Following the early majority according to Rogers (2003) is the late majority. These are individuals who tend to adopt new ideas after the average member of society and they are likely more skeptical of new ideas. Rogers (2003) determined that they are skeptical about the innovation and its outcomes and that peer pressure could play a role in their decision to adopt an innovation or not.

Finally, Rogers (2003) defines the last group as laggards. This group is comprised of those individuals who are last in a social system to adopt new ideas. Rogers (2003) says that they carry more traditional views and are skeptical about innovations and change agents as opposed to the late majority. They are considered a localized group of their social system and their interpersonal networks include only other members of the social system from the same category (Rogers, 2003). Laggards do not possess leadership roles and because of limited resources and a lack of awareness and knowledge of innovations, they prefer to see if an innovation works prior to adopting it

(Rogers, 2003). With regard to Roger's characteristics of adopter categories, many of his generalizations can be applied directly to the research objectives of this study.

Under the heading of socioeconomic characteristics, Rogers (2003) generalized that earlier adopters were no different from later adopters when referring to age. He also held that earlier adopters had more years of formal education that did later adopters and had a higher social status than did later adopters. Rogers (2003), when referring to status, included variables such as income, possession of wealth, occupational prestige and a self-perceived identification with a social class. Rogers (2003) further generalized that earlier adopters had a greater degree of upward social mobility when compared to later adopters.

Characteristics of Innovations That Impact Adoption

There are five characteristics of an innovation that impact adoption. According to Rogers (2003), these include relative advantage, compatibility, complexity, trialability, and observability. Rogers (2003) describes relative advantage as the degree to which an innovation is perceived as being better than the existing standard. Simply put, is the innovation better than what was previously available? Depending on what type of innovation is being suggested, the relative advantage could be economic and social in nature. Rogers (2003) also notes that the characteristics of the relative advantage can change as the rate of adoption of the innovation increases.

The second characteristic as identified by Rogers (2003) is compatibility, which is defined by the degree to which an innovation is perceived as consistent with the adopter's existing values, his or her past experiences, and the needs of the potential adopters. The individual considering adoption must be able to understand how this innovation works and what it means to their operation.

The next characteristic is complexity (Rogers, 2003). This pertains to how easy it is for people to understand and use the innovation. Rogers (2003) suggests that there is a negative relationship between the complexity of an innovation and the rate of adoption. If the innovation is too difficult to understand or use, then it can be viewed as a barrier to the adoption process and the individual is less likely to adopt.

Trialability is the next characteristic that can affect adoption. Trialability is the degree to which an innovation can be experimented with prior to adoption (Rogers, 2003). Rogers (2003) found that new ideas that could be tried on an installment plan basis were generally more likely to be adopted. This led to Rogers' (2003) generalization that "the trialability of an innovation, as perceived by the members of a social system, is positively related to its rate of adoption" (p.258).

Lastly, observability can have an impact on the adoption of an innovation. Observability is the degree to which others can see the results of an innovation (Rogers, 2003). When an innovation is highly visible, other people are more likely to share what they have seen and this will increase the likelihood of adoption by other individuals. An example of observability would be a side-by-side in- field trial. These are often done on farms to demonstrate growth characteristics and habits of a particular row crop variety. They are usually placed in highly visible areas where a maximum number of producers can see the results. Observability, like trialability, is positively related to its rate of adoption. An understanding of the abovementioned characteristics of an innovation is essential in order to determine the nature of the adoption process (Rogers, 2003).

Factors Affecting Adoption of Precision Agriculture

There can be many reasons influencing a decision to adopt an agriculture innovation. These reasons can be classified into Rogers' model (2003) of the innovation decision process (Figure 1). These can include cost savings (socio-economic characteristics), perception (felt needs), social factors (norms of the social system), and risk (problems).

The size of the farm has been shown to affect a farmer's decision to adopt a precision agriculture technology. Research conducted by Fernandez-Cornejo, Klotz-Ingram, & Jans (2002) and Castle et al. (2016), indicated that the size of the farm could affect the decision to adopt a precision agriculture technology. Their analysis indicated a higher probability of farmers adopting precision agriculture technologies as the size of the farm increased. The study also indicated that the farmers' decision to invest in precision farming technology was related to its potential to earn the farmer a profit. Daberkow and McBride (1998) found that farm size, profitability, productivity, and location were factors that affected the adoption process and that those factors were statistically significant and positively affected the precision technology adoption decision.

Research conducted by Fernandez-Cornejo et al. (2002) and Castle et al. (2016), showed similar results with regard to size of farm. Their data indicated a higher probability of farmers adopting precision agriculture technologies as the size of the farm increased.

Cost savings associated with the innovation and perceptions were studied by D'Antoni et al. (2012). Their research examined whether or not farmers perceived precision agriculture technologies as something that could offer them a cost savings in their farming operation. The authors postulated that cotton farmers must see potential for higher profits as a result of adopting precision technologies in order to adopt. Farmers' decisions regarding adoption of auto steer are assumed to be based the value they place on input cost savings (D'Antoni et al., 2012). The authors also concluded that farmers may perceive cost savings using auto steer technology as greater than they actually are. The study further stated that farmers who adopt precision technologies are future-focused, leading them to choose more advanced technology which will render larger dividends over a longer period of time. In some situations, a technological innovation may be just one component of a larger package of options that is being offered. In this scenario the farmer may not want the whole package but instead might be interested in just one component which might be less expensive than the entire package. Smale and Heisey (1993) investigated the reason why farmers adopted only parts of the technological package associated with the innovation. This adoption took place in a step-wise manner as opposed to adopting the entire package at once. They found that it is important to consider and account for the relationships between the components of the innovation package in order to make the farmer fully understand how the whole process worked in conjunction with each item and the savings potential for inclusion.

Additionally, according to Adrian, Norwood, and Mask (2005), it is understood that economic benefit is one of the primary reasons for adoption of an innovation by producers. Batte and Arnholt (2003), indicated that profitability was the biggest motivating factor in using precision agriculture tools. This can be applied directly to the adoption of present day precision agriculture technologies. According to

Schimmelpfennig (2016), even if there is a technology that increases farm profits, the adoption process of this technology is often slow during the initial stages and then tends to speed up as time progresses. One such increase was noted by Schimmelpfennig and Ebel (2011) when they examined the adoption of precision agriculture technologies from 1997 to 2005. Schimmelpfennig (2016) attributes this increase over time to farm characteristics and the learning curve that is required to integrate new technologies into existing practices. Schimmelpfennig (2016) also found that adoption rates varied significantly across precision agriculture technologies stating that yield monitors that produce the data for GPS-based mapping systems were the most widely adopted and used on about half of all corn and soybean farms involved in his research. Conversely, guidance systems, or auto-steer, were used on about one third of those farms.

The second factor found by D'Antoni et al. (2012) that plays a role in the adoption of a precision agriculture innovation is the farmers' perception of the innovation. If a farmer doesn't think that an innovation will work in their operation or that it won't provide a benefit to them or save them money, then they won't adopt it. Gandonou, Dillon, Kanakasabi, and Shearer (2002) found the lack of perceived benefits delivered by precision agriculture was an obstacle that must be overcome in order for a farmer to adopt. It's important to note that farmers' experiences with one type of precision agriculture will likely affect their perception of future precision agriculture technologies and eventually their decision to adopt (D'Antoni et al., 2012). What farmers think about an innovation can weigh heavily on their decision to adopt an innovation. Alonge and Martin (1995) conducted a study dealing with sustainable agriculture and farmers' perceptions of this innovation. The descriptive survey concluded that the majority of the farmers had very positive perceptions of sustainable agriculture practices. The regression analysis further showed that the indicators of education, farm size, and tenure arrangement were poor predictors of farmers' adoption rates even if their perceptions were positive concerning sustainable agriculture practices.

Another reason that could affect the decision to adopt are social factors. This encompasses areas such as group communication, the producers' attitude, and awareness of an innovation. Rogers (2003) states in his generalizations about adopters, that earlier adopters have more social participation than do later adopters and they are more highly interconnected through interpersonal networks in their social system. A study conducted by Baumgart-Getz, Prokopy, and Floress (2012) showed that adoption of best management practices were only slightly influenced by social factors such as communication networks among producers, overall attitudes, environmental awareness, and heritage. They further suggested that effective adoption efforts should include a combination of complementary social factors in order to achieve maximum impact. This research further suggested that getting farmers to adopt best management practices would require educators to utilize a two-step approach. The first step would have an implementation focus that would target those farmers that were most likely to adopt innovation. The second step would involve increasing the individual capacity and awareness by utilizing networks to inform other farmers about the benefits of adoption. This implies that a strong communication channel can assist in the adoption process.

Risk is another consideration that can have a major effect on adoption of a precision agriculture technology (Marra, Pannell, & Ghadim, 2002). Lidner, Pardey, and Jarrett (1982) also found that risk was considered to be a major factor that could reduce the rate of adoption of a new technology. Risks are commonplace when looking at a farming operation and these risks can be the reasons a farmer decides to postpone the use of an innovation until they feel more assured that the benefits outweigh the risks. According to Lowenberg-DeBoer (1999), precision agriculture may actually increase some types of risks such as human and technological risks. He states that more than most previous new technologies in agriculture, the profitability of precision farming depends on human capital. Someone must have the skills that are needed in order to operate the equipment and interpret the data collected. In other words, if there is a multi-person farming operation that is utilizing a precision agriculture technology, frequently one of the partners will specialize in the precision agriculture component of the farming operation. This causes the operation to be vulnerable if that one person is no longer available (Lowenberg-DeBoer, 1999).

Perceived riskiness was observed by O'Mara (1983) in new varieties of grains proposed for use in Mexico. Those estimates of the riskiness of grain crops were found to influence the actual adoption decisions of the farmers. According to Sahin (2006), to reduce this risk of uncertainty, individuals should be informed about advantages and disadvantages in order to make them aware of the consequences associated with the innovation. This can be achieved through thorough investigation and communication of the perceived benefits and limitations of the innovation.

Llewelyn (2011) suggested the idea that in order to get farmers to adopt something you must target those farmers that would most likely adopt. This was also suggested by Baumgart-Getz et al (2012). This group of farmers might be considered the innovators and the early adopters according to the stages as set forth by Rogers (2003).

According to Veen (2010), when dealing with agriculture innovations and adoption, it is important to understand that many of the changes and improvements that have been made in agriculture are small and incremental as opposed to being large and radical. These changes also involve adaptations that fit local circumstances. Generalizations concerning how a farmer will utilize an innovation can be difficult to define since farmers might change an innovation to better suit their needs within their operation (Veen, 2010).

Extension Service History and Role in Adoption

The Extension Service was created with the passage of the Smith Lever Act in 1914. The Smith–Lever Act is a United States federal law that established a system of cooperative extension services, connected to the land-grant universities, in order to inform people about current developments in agriculture, home economics, public policy/government, leadership, 4-H, and economic development. With the passage of the Smith-Lever Act, the MSU Extension Service was formed. The mission of the MSU Extension Service is to "provide research-based information, educational programs, and technology transfer focused on issues and needs of the people of Mississippi" (About extension, 2018). These activities should enable clients to make informed decisions about their economic, social, and cultural well-being and in turn help them compete in a local, state, and global economy.

The goal set forth by the MSU Extension Service is to address rural and agriculture issues within the state (About extension, 2018). One of the primary objectives was to bring agriculture research information to producers so they can make changes or adjustments in order to maximize their profitability and ensure their operation is functioning efficiently. Included within this research-based information are innovations at the forefront of agriculture. Once this information is disseminated, producers then have opportunity to decide whether to adopt the innovation or not.

A study conducted by Rollins (1993) found effective change agents can use the information concerning innovations to target both cooperators, collaborators, as well as prospective clientele, who may not have been previously identified. Rollins (1993) further suggests that educational programs, such as those offered through the Extension Service, need to be specifically designed for each unique group of adopters.

In another study conducted in Tennessee by Roberts, English, and Larson (2002), data dealing with precision agriculture adoption issues suggested that the Tennessee Institute of Agriculture needed to target its programs to counties with estimated probabilities of adoption greater than 0.5. Those counties with probabilities greater than 0.5 were also determined to be good candidates for precision farming programs which would most likely benefit farmers, agribusiness personnel, and the agriculture workforce. By being able to focus educational programs to those counties that might have greater probabilities to utilize precision farming programs, the Tennessee Institute of Agriculture should enhance the program efficiency of their organization.

Promotion of precision agriculture innovations can also play a role in the adoption process. Many times, Extension agents implement educational programming efforts that might highlight different agriculture innovations. During an event such as this, producers will have the opportunity to examine the pros and cons of a new idea. King and Rollins (1995) suggested that when promoting agriculture innovations, educational programs should include economic as well as technical information. Their study further stated that potential adopters of precision agriculture technologies required an affiliation with at least three communication networks in order to gain information and learn how to use agriculture innovations. These networks included a social communication network, a clique or unique group, and a personal communication network. They also found that extension agents' attitudes could impact the adoption of an agricultural innovation and that extension agents needed to be enthusiastic and motivated in order to promote the adoption of an innovation.

King and Rollins (1999) later found that technological change has been the basis for increasing agriculture productivity and promoting agriculture development. They also noted that historically, researchers and change agents have been the ones primarily responsible for identifying and incorporating the economic and environmental factors in the process of the development and introduction of the agriculture innovation. According to Lanyon (1994), this change agent process is referred to as a transfer of technology and is characterized by a top down process where the researchers are responsible for the development of the innovation, the change agents promote its use and acquisition, and then the farmers either adopt or reject the innovation.

CHAPTER III

METHODOLOGY

Research Design

This study was exploratory in nature and utilized four independent variables. The independent variables included geographic location, size of the farm, age of the farmer, and educational level. The study examined if any of the independent variables could be used as predictors of auto-steer use. The dependent variable in the study was the use of auto-steer. Data were collected by utilizing a survey instrument that was emailed to Mississippi row crop producers. Data collected included information concerning the farmer's use of auto-steer, geographic location, the farmer's age, education level, and reasons why the farmer elected to utilize auto-steer in their operation or not. Dillman's (2011) methods for collecting survey data were followed with slight modification to accommodate email as opposed to letters.

The survey instrument was developed based upon a survey from the University of Tennessee Department of Agricultural and Resources Economics. Permission was received from Dr. Roland Roberts with the University of Tennessee to use their survey as a template for the instrument used in this study. Their survey consisted of sixty-three questions and covered twelve states in the southeast United States.

The research utilized Qualtrics for the survey construction, distribution, and data collection. The survey consisted of 17 questions that relate directly to the Mississippi and the independent variables of geographic location, age of the farmer, size of the farm, and educational level of the farmer.

Population and Sample

According to USDA Census of Agriculture (2017), there are 35,800 farms in Mississippi. This number is representative of all farming operations in Mississippi but is not limited to traditional row crop farmers. The sample was representative of Mississippi row-crop farmers only. A total of 152 surveys were collected.

The email list of producers utilized was created by contacting Extension agents throughout the state and inquiring if they had an email list of row crop producers that would be available for use with this project. Permission was granted by the Director of the MSU Extension Service to contact these agents and request the email lists (Appendix B). The total population of the list totaled 1154 email addresses. The primary list consisted of 434 producer email addresses. A second list was also utilized that was provided by the Mississippi Farm Bureau Federation crop specialist for Mississippi. This list included a total of 720 row-crop producer emails. The link to the survey instrument was then emailed to all of the row-crop producers on the combined list.

Instrumentation

This research was quantitative in nature and utilized a researcher-modified survey instrument developed by the Department of Agricultural Economics at the University of Tennessee in Knoxville, TN in 2001. The survey utilized by the University of Tennessee (Roberts et al, 2001) dealt with only cotton producers in the southeast United States. The original survey was modified with permission from the University of Tennessee to meet our research objectives in Mississippi.

The survey instrument consisted of 17 questions as listed in Table 1.

Table 1 Qualtrics Survey Instrument Questions

Question	Response choices
1. What are the primary County and State in which your farm is located?	Fill in the blank with county and state.
2. In what year were you born?	Drop down menu selection.
3. What drops do you grow?	Choices include: Corn, Cotton, Milo, Peanuts, Rice, Soybeans, Wheat, and Other.
4. How many years have you been farming?	Fill in the blank.
5. How many acres do you farm?	Fill in the blank.
6. What is the highest level of education that you've attained?	Choices include: Some high school, high school diploma/GED, associate's degree, graduate/professional degree, some college, some graduate school.
7. Do you use electronic devices in farm management decisions outside of field work?	Yes or No
8. What devices do you use to make farm management decisions?	Choices include: Laptop, tablet, smartphone, handheld GPS, soil moisture meters, other.
9. *Do you utilize auto-steer on any piece of your farm equipment?	Yes or No
10. Please rate the following factors based upon importance in your decision to not use auto-steer: Profitability, integration into existing equipment, difficulty of learning to use, tying it beforehand, positive environmental benefits, being able to see others use auto-steer before purchase, and saving time.	Factors were rated in a Likert scale format from 1 = not important at all, to 5 =absolutely essential.
11. For which field operations do you use auto-steer?	Choices include: Tillage, planting, spraying, cultivating, harvesting.

Table 1 (continued)

12. In what year did you first implement auto-steer?	Fill in the blank.
13. Please rate the following factors based upon importance in your decision to use auto-steer. These included: profitability, integration into existing equipment, difficulty of learning to use, tying it beforehand, positive environmental benefits, being able to see others use auto-steer before purchase, and saving time.	Factors were rated in a Likert scale format from 1 = not important at all, to 5 =absolutely essential.
14. Has the use of auto-steer met your expectations?	Factors were ranked in a Likert scale format from 1 = has not met my expectations at all, to 4 = has exceeded my expectations.
15. Have you attended an MSU Extension educational event or presentation regarding precision agriculture?	Yes or No
16. Have you used MSU Extension publications to obtain precision agriculture information?	Yes or No
17. To have your name removed from further reminders to complete this survey, please provide your email address in the space provided.	A blank space was provided where the respondent could include his or her email address for removal from further reminders.

Note: *Question 9 represented a stop-gap. If the respondent's answer was no, they were directed to question 10 then ended the survey. If the respondent answered yes to question 9, then they were directed to question 11 and continued with the survey.

Reliability and validity refer to the repeatability of the findings of a survey instrument and how well the instrument measures what it is purported to measure, respectively. Face validity and construct validity for the survey instrument was evaluated. Face validity is important in surveys such as this one because it lets the researcher know if the content of the instrument matches the objectives of the research. Construct validity is also important in that it assesses whether or not the instrument actually measures what it is intended to measure. In order to accomplish this task, the survey instrument was designed with help from an evaluation specialist and faculty members. A pilot test was also performed in order to ensure the face validity of our survey instrument. A panel of experts were utilized to pilot test the survey instrument. These included Extension Agents as well as row crop producer volunteers. After this panel completed the pilot test they were asked to give their opinions as to the appropriateness of the questions and if they had any difficulties in answering any of the questions. Participants in the study were asked to complete the survey to the best of their ability and they were instructed that they could cease answering questions at any time. Modifications to the survey were based upon input from the participants to enhance its effectiveness as well as look and feel. These included removing some questions that were not directly related to the goals of this research and correcting a problem with the execution of the stop-gap question.

Reliability was tested using Cronbach's alpha utilizing the scaled questions from the survey instrument that included "What is the highest level of education that you have received?" and "Please rate the factors involved in your decision to use auto-steer". This analysis resulted in a Cronbach's alpha level of .825.

Data Collection Procedures

All research involving human subjects must be reviewed and approved by the Mississippi State University Institutional Review Board (IRB) before researchers may begin their studies. Initial IRB approval was obtained for this study prior to all data collection (Appendix A).

The survey instrument link was emailed to the producers on January 31, 2018. Follow-up requests were emailed on February 19, 2018 and on March 12, 2018. Participation was completely voluntary, and participants could stop responding at any point. Producers had the opportunity to include their email address in order to be removed from the list and not receive any additional reminders to complete the survey.

Data Analysis

Data from the surveys were downloaded from Qualtrics and placed into IBM SPSS (ver. 24). SPSS is an acronym for Statistical Package for the Social Sciences. Data regarding the size of the farm, geographic location, age of the farmer, and educational level were placed into a binary logistic regression model for analysis. The model utilized the enter method for logistic regression. This method allows the examination of each independent variables into the equation at the same time. By doing so, each predictor is assessed as though it were entered after all the other independent variables were entered to assess what it offered to the prediction of the dependent variable.

These data were also analyzed for descriptive analyses. Responses from questions 10 and 13 were analyzed using a repeated measures ANOVA.

CHAPTER IV

RESULTS

The purpose of this research is to determine the relationships between selected farm and farmer characteristics and the adoption of auto-steer by farmers in the state of Mississippi. The variables include geographic location, size of the farm, age of the farmer, and educational level of the farmer. This research will attempt to determine if these variables could be used as predictors of whether or not a farm operator is going to adopt the precision agriculture technology called auto-steer. The following research objectives were used to guide this study:

1. Describe the characteristics of farming operations in Mississippi with regard to geographical location, size of the farm, age of the farmer, and educational level attained by the farmer.
2. Determine the interaction between the use or non-use of auto-steer and the variables of: geographical location, size of the farm, age of the farmer, and educational level of the farmer.
3. Identify reasons underlying the decision to adopt auto-steer.

Research Objective One

Research objective one was to describe the characteristics of farming operations in Mississippi with regard to geographical location, size of the farm, age of the farmer, and educational level attained by the farmer. Mississippi has 82 counties located within the state boundaries encompassing 48,430 square miles encompassing two types of farm land. All of the respondents involved in this research were Mississippi farmers.

Out of the 1154 emails that were sent, a total of 152 surveys were completed. Respondents were sent reminders to aid in increasing the response rate. The 152 surveys completed represented a 13.1% response rate. Of the respondents, approximately 48.2% indicated that their primary farming operation was located in the Delta counties while the remaining 51.8% were located in the Hill counties (Figure 3).

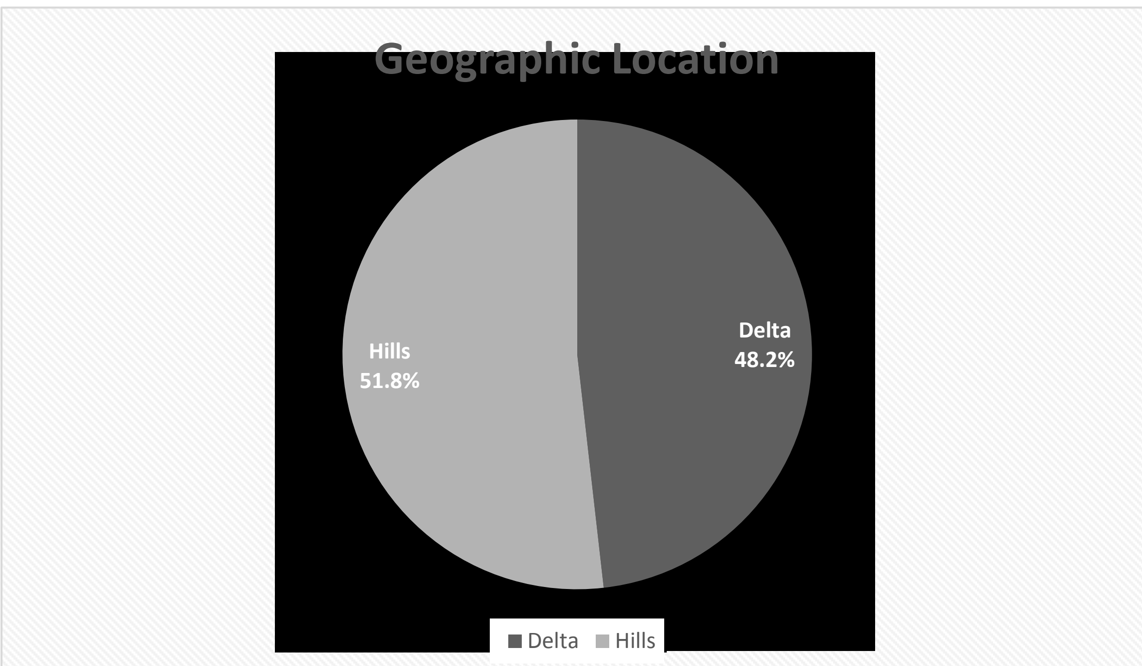

Figure 3 Geographic location of respondents

n = 152

Crops being farmed by respondents (n = 152) included corn (80.0%), soybeans (85.5%), cotton (48.7%), wheat (23.0%), rice (15.8%), milo (9.2%), and peanuts (5.3%) (Figure 4).

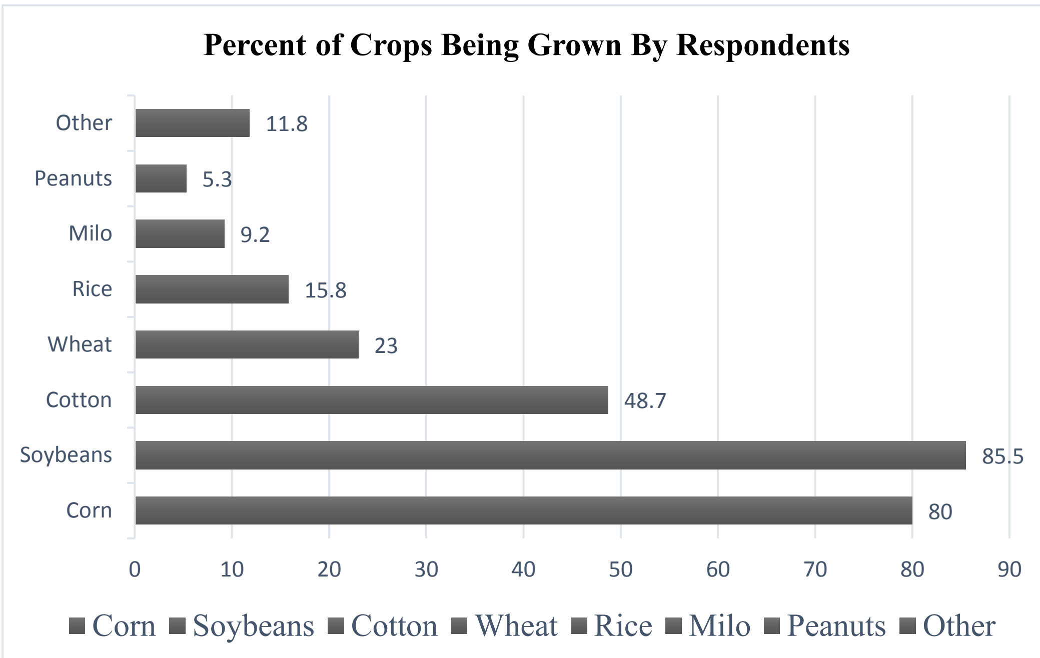

Figure 4 Crops grown by respondents

n = 152
"Other" crops include sweet potatoes, oats, and pumpkins

Of the respondents, age ranged from 19 to 82 years old. The mean age of the respondents was 48.07 years with an average farm size of 3153.28 acres (Table 2). Respondents had been farming a mean of 26.51 years and the mode for adopting auto-steer was 2010 (Table 2).

Table 2 Respondent characteristics

	n	Range	Min.	Max.	Mean	Mode	Std. Dev.
Age	152	63	19	82	48.07	59	13.818
Year that the farmer adopted auto-steer	152	22	1995	2017	2010	2010	4.60
Size of the farm	152	15960	40	16000	3153.28	1500	3082.48
Number of years farming	152	60	0	60	26.51	40	14.09

Note: Size of farm is expressed in acres

Respondents (n = 152) indicated their educational level as follows: 1- Some high school, 2- High school diploma/GED, 3- Associate's degree, 4- Bachelor's degree, 5- Graduate/Professional degree, 6- Some college, and 7- Some graduate school. In order to correctly indicate the increase in educational level, the decision was made to group "some college" and "some graduate school" into already present groups. Those respondents who indicated that their level of educational attainment was "some college" were then grouped with associate degree (selection 3). Those who indicated their choice as "some graduate school" were grouped with "graduate/professional degree". This provided a clearer order in the scale and the analysis made more sense (Table 3). The educational level of the respondents (n = 149) included the following: some high school (7.3%), high school diploma/GED (14.8%), associate's degree (23.5%), bachelor's degree (43.0%), and graduate/professional degree (11.4%) (Table 3).

Table 3 Educational Level of Respondents

	Frequency	Percent
Some High School	11	7.3
High School Diploma/GED	22	14.8
Associate's Degree	35	23.5
Bachelor's Degree	64	43.0
Graduate/Professional Degree	17	11.4
Total	149	100

n = 152
Note: 1 = some high school, 2 = high school diploma/GED, 3 = associates degree, 4 = bachelor's degree, 5 = graduate/professional degree.

Research Objective Two

Research objective two was to determine the interaction between the use of auto-steer and the variables of geographical location, size of the farm, age of the farmer, and educational level of the farmer. For this objective, descriptive statistical analysis and binary logistic regression analysis in IBM© SPSS© was used to analyze the data. Since we were using a small set of predictors, the enter method was used in the logistic regression. This is a standard method of entry of the independent variables into the equation at the same time. By doing so, each predictor is assessed as though it were entered after all the other independent variables were entered in order to assess what it offered to the prediction of the dependent variable.

Of the 152 respondents, 119 indicated they used auto-steer (78.8%) and 33 indicated they did not use auto-steer (21.2%). Analysis indicated that overall model fit increased from 77.4% to 86.5% across all variables (Tables 4 and 5). Nagelkerke R^2 = .499 indicating that 49.9% of the variability was accounted for by the independent variables (Table 6).

Table 4 Baseline Classification Table

		Predicted Do you use auto-steer on any piece of your farm equipment		
Observed		No	Yes	Percentage Correct
Do you utilize auto-steer on any piece of your farm equipment	No	0	30	.0
	Yes	0	103	100.0
Overall Percentage				77.4

Table 5 Classification Table after Enter Method Applied

		Predicted Do you use auto-steer on any piece of your farm equipment		
Observed		No	Yes	Percentage Correct
Do you utilize auto-steer on any piece of your farm equipment	No	17	13	56.7
	Yes	5	98	95.1
Overall Percentage				86.5

Table 6 Omnibus Tests of Model Coefficients

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	89.260	.327	.499

The Hosmer and Lemeshow test was also performed within this study to determine if the differences between the observed and expected response proportions were significant. If the result was significant, then it would indicate a lack of model fit. After analysis, the Hosmer and Lemeshow Test indicated a non-significant result (p = .661), which further emphasizes that the model represents an improvement in model fit (Table 7).

Table 7 Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.877	8	.661

Examining all of the independent variables within the model indicates that geographic region (p = .613) does not significantly effect a farmer's probability of adopting auto-steer (Table 8). Likewise, level of education (p = .081) did not significantly effect a farmer's probability of utilizing auto-steer. Age of the farmer ($p < .05$) and the size of the farm ($p < .001$) were both shown to significantly effect a farmer's probability of adopting auto-steer (Table 8). The correlation matrix (Table 9) indicates the relative correlations of the independent variables used in the model. Geographic location was positively correlated with educational level and size of farm but was negatively correlated with the age of the farmer. Level of education was positively correlated with geographic location and age but was negatively correlated with size of the farm. Age was positively correlated with educational level and age but was negatively correlated with geographic location and size of the farm. The last independent variable of size of the farm was positively correlated with geographic location but was negatively correlated with educational level and age of the farmer.

Table 8 Regression Analysis with all independent variables accounted for

	B Coef	S.E.	Wald	Exp (B)	95% C.I. for EXP(B) (Lower Upper)	Sig.
Geographic location	-.317	.627	.256	.728	.213, 2.489	.613
Level of Education	-.406	.232	3.054	.666	.423, 1.051	.081
Age	-.047*	.019	5.896	.954	.918, .991	.015
Size of Farm	.001**	.000	13.612	1.001	1.001, 1.002	.000
Constant	3.062	1.45	4.456	21.370		

Nagelkerke R^2 = .499; Model X^2 = 52.747, $p < .001$
*$p < .05$, **$p < .001$

Table 9 Correlation Matrix

	Constant	Geo Location	Ed. Level	Age	Size of Farm
Constant	1.000	-.401	-.685	-.657	-.110
Geo Location	-.401	1.000	.106	-.075	.272
Ed. Level	-.685	.106	1.000	.180	-.061
Age	-.657	-.075	.180	1.000	-.309
Size of Farm	-.110	.272	-.061	-.309	1.000

Research Objective Three

Research objective three was to determine the reasons underlying the farmers' decision to use auto-steer. Use of auto-steer was determined with Question 9 in the survey instrument. If respondents indicated that they did use auto-steer on any piece of equipment, they were also asked to rate their reasons in order of importance as to why they did use auto-steer (Table 10).

Table 10 Reason to "use" auto-steer in order of importance

	Mean	Standard Deviation
Saves time	4.44	.666
Profitability	4.00	.862
Ease of integration	3.90	.902
Positive environmental benefits	3.50	1.083
Difficulty of learning	3.14	1.021
Seeing others use the innovation	2.92	1.057
Being able to try the equipment beforehand	2.91	1.179

n =152

Responses ranged from 1 – Not important at all to 5 – Absolutely essential.

Saving time was rated as the most important by respondents who utilized auto-steer (Table 10). Saving time had a mean of 4.44 and a standard deviation of .666. The second most important reason that farmers chose to use auto-steer was profitability (Table 10). Profitability had a mean of 4.00 and a standard deviation of .862. The data for profitability is similar to the findings of Batte and Arnholt (2003) which indicated that profitability was one of the largest motivating factors in using precision agriculture tools. The third most important reason that was indicated was the ease of integration into existing equipment with a mean of 3.90 and a standard deviation of .902. The remaining ratings of the reasons to use auto-steer in order of importance included positive environmental benefits, difficulty of learning, seeing others use the innovation, and being able to try the equipment beforehand. Pairwise comparisons were conducted to examine if there were differences among the reasons to adopt auto-steer (Table 11).

CHAPTER V

CONCLUSIONS

When examining factors involved in a farmer's decision to adopt an innovation, it is important to remember that there could be many factors that may influence this decision. Knowing which factors affect the farmer's decisions is vitally important to the Extension Service in that it helps the organization to better prepare and present educational programming that will benefit farmers. Fostering a strong, trusting relationship with farmers is key to understanding the motivation behind their actions as well as what they consider important in their farming operation. The data and results presented in this research study offers a view into the decision making process of farmers within Mississippi and their motivations behind their choices.

Research Objective One

The first research objective of this study was to describe the characteristics of farms and farmers within the state of Mississippi. The characteristics analyzed included geographical location, size of the farm, age of the farmer, and educational level of the farmer. For the purpose of this study, the state of Mississippi was divided into two geographic locations. These included Delta and Hill counties. Of the 152 respondents, 48.2% indicated that their farms were in Delta counties while 51.8% indicated Hill counties. All of the respondents involved in this research were Mississippi farmers.

A total of 152 survey instruments were completed. This represented a 13.1% return rate. Similar return rates were noted in research conducted at the University of Tennessee that reported a 12.5% return rate among twelve states (Mooney et al, 2010).

Among the respondents within our study, 75.0% indicated that they utilized auto-steer in their farming operation while the remaining 25.0% indicated they did not (n = 152). Average age of the farmers surveyed was 48.07 years. This average is lower than the national average of 58.30 years as reported in the USDA Ag Census (2012) and lower than the 53 years as reported by Mooney et al. (2010). Average farm size of respondents was 3153.28 acres (Table 2) which is larger than the average of 299 acres as reported by the USDA Census of Agriculture (2017).

When looking at the educational level of the respondents, forty-three percent of the respondents held a bachelor's degree. This is similar to data reported by Mooney et al. (2010) which indicated that forty-five percent of the respondents in their study had completed a college degree.

The mode year of adoption of auto-steer was 2010 (n = 114) which represented 10.5 percent of the respondents (Table 2). The earliest date of adoption that was reported was 1995. The average years of farming for the respondents was 26.51 (n = 152) (Table 2).

Respondents within the study indicated that they grew a variety of crops which included: corn (80.0%), soybeans (85.5%), cotton (48.7%), wheat (23.0%), rice (15.8%), milo (9.2%), peanuts (5.3%) and other (11.8%). The category of "other" included sweet potatoes, oats, and pumpkins (n = 152) (Figure 3). Data for Mississippi as reported by USDA (2017) indicated the following: corn (21%), soybeans (59.2%), cotton (12.6%), wheat (15%), rice (5.7%), milo (<1%), peanuts (1%). There are some differences between numbers reported by USDA for Mississippi and this study which could be attributed to the sample size.

Research Objective Two

Research objective two was to determine the interaction between the use or non-use of auto-steer and the variables of: geographical location, size of the farm, age of the farmer, and educational level of the farmer. The binary logistic regression model showed significant improvement after all the independent variables were included (Tables 4, 5,). Overall model fit increased from 77.4% to 86.5% which represents an improvement in the model due to the independent variables being introduced into the equation.

Geographic Location

As this study began, the hypothesis concerning geographical area was that it would be a significant predictor of whether or not a farmer would use auto-steer. Logic suggests that land in the Delta is more level with smaller changes in elevation, better defined field edges, and fewer trees. This should make it easier to implement an auto-steer system. The Hills area, on the other hand, represented farmland that included more elevation changes in smaller fields with irregular borders and oftentimes surrounded by trees. These conditions would suggest that it would be more difficult and impractical to implement an auto-steer system. Results of the logistic regression analysis indicated that the assumption of geographical location being a significant predictor of auto-steer use was incorrect.

Examining all of the independent variables within the model indicates that geographic region does not significantly affect a farmer's probability of adopting auto-steer (Table 8).

Size of Farm

The research hypothesis for this study concerning the size of the farm was that the larger the farm then the more likely the farmer would be to adopt auto-steer. The logistic regression analysis illustrated that size of the farm had a significant effect ($p < .001$) on the probability that the farmer will adopt auto-steer (Table 8). This is similar to data presented by Fernandez-Cornejo et al. (2002) and Castle et al. (2016), which indicated that the size of the farm could affect the decision to adopt a precision agriculture technology. Their study showed a higher probability of farmers adopting precision agriculture technologies as the size of the farm increased. In other words, the larger the farm in acres, the more likely a farmer is going to use auto-steer. This conclusion is in agreement with Rogers (2003) who stated that earlier adopters have larger-sized farms, schools, or companies. The regression analysis also indicated that the size of the farm was the strongest predictor among independent variables involved in this study compared to age, educational level and geographic location (Table 8). This can be attributed to size of farm having the largest beta coefficient (Table 8).

Age of Farmer

This study hypothesized that the older a farmer then the less likely they were to adopt auto-steer. The mean age of the farmers who participated in the study was 48.07 years (n = 152) with a standard deviation of 13.82 (Table 2). Analysis of the data indicated that the age of the farmer had a significant effect on the probability of a farmer adopting auto-steer ($p < .05$) (Table 8). This result is contrary to Rogers (2003) who suggested that "early adopters are no different from later adopters in age." He further states that half of the diffusion studies that he examined showed no relationship amongst age while a few found that earlier adopters were younger, and some were older (Rogers, 2003).

Data in this study indicated that beta (B) for age of the farmer was negative. This would indicate that the younger a farmer is, the more likely he or she is to adopt auto-steer. Further analysis indicates that the younger a farmer is, they are more likely to adopt auto-steer as opposed to older farmers. This coincides with data presented by Castle, et al. (2016) whose research showed that older producers adopt fewer agriculture technologies as opposed to younger farmers.

Level of Education

This study also hypothesized that the higher the level of education of the farmer then the more likely they would be to adopt auto-steer. However, level of education was not a significant predictor of whether or not a farmer would utilize auto-steer (Table 8). However, general descriptive analysis seems to indicate that the higher a farmer's educational level is, the lower the probability is that they will adopt auto-steer (B =-.406, $p = .081$) (Table 8). In this instance, experience could play a superior role when compared to education level. This is supported by Rogers (2003) generalization that earlier adopters have more years of formal education than do later adopters but is not supported by the data in this study.

Research Objective Three

Research objective three was to determine the reasons behind the decisions to use auto-steer. Respondents ranked the reasons why they used auto-steer. The respondents ranked saving time, profitability, and integration into existing systems as their top three reasons for using auto-steer or not (Table 11).

The data indicate that respondents who used auto-steer felt that saving time and profitability were the two most important factors in their decision to adopt or not adopt auto-steer. This indicates that adopters of auto-steer recognize the importance of time saving and profitability which could translate to an economic savings for their operation. The data for profitability is similar to findings of Batte and Arnholt (2003) that indicated that profitability was the one of the largest motivating factors in using precision agriculture tools. It is interesting to note that the reason of seeing others use the innovation was ranked as second to last. One would think that if a farmer noticed his neighbor utilizing auto-steer on a piece of equipment that he or she might be inclined to do likewise. The data suggest that this is not one of the main reasons that the decision to adopt is made.

Pairwise comparisons were conducted to determine if any differences existed among the top three reasons for using auto-steer. Examining the top three reasons why farmers adopted auto-steer, the top reason of saving time was significantly different from profitability and ease of integration ($p < .001$) (Table 10). The second most important reason was profitability. Profitability was not significantly different from ease of integration ($p = .357$).

Table 11 Pairwise Comparisons among reasons from farmers adopting auto-steer

UsingAutosteer		Mean Difference	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Profitability	Ease of integration	.096	.104	.357	-.110	.303
	Difficulty of Learning	.860*	.109	.000	.643	1.076
	Being able to try equipment	1.088*	.115	.000	.859	1.316
	Positive environmental benefits	.500*	.105	.000	.292	.708
	Seeing others use the innovation	1.079*	.109	.000	.864	1.294
	Saves time	-.439*	.086	.000	-.610	-.268
Ease of integration	Profitability	-.096	.104	.357	-.303	.110
	Difficulty of Learning	.763*	.112	.000	.541	.986
	Being able to try equipment	.991*	.127	.000	.740	1.242
	Positive environmental benefits	.404*	.116	.001	.174	.633
	Seeing others use the innovation	.982*	.117	.000	.751	1.214
	Saves time	-.535*	.101	.000	-.734	-.336
Difficulty of learning	Profitability	-.860*	.109	.000	-1.076	-.643
	Ease of integration	-.763*	.112	.000	-.986	-.541
	Being able to try equipment	.228*	.101	.026	.027	.429
	Positive environmental benefits	-.360*	.120	.003	-.598	-.121
	Seeing others use the innovation	.219	.113	.056	-.005	.444
	Saves time	-1.298*	.111	.000	-1.519	-1.078
Being able to try the equipment	Profitability	-1.088*	.115	.000	-1.316	-.859
	Ease of integration	-.991*	.127	.000	-1.242	-.740

Table 11 (continued)

	Difficulty of learning	-.228*	.101	.026	-.429	-.027
	Positive environmental benefits	-.588*	.131	.000	-.848	-.328
	Seeing others use the innovation	-.009	.105	.934	-.218	.200
	Saves time	-1.526*	.121	.000	-1.766	-1.287
Positive environmental benefits	Profitability	-.500*	.105	.000	-.708	-.292
	Ease of integration	-.404*	.116	.001	-.633	-.174
	Difficulty of learning	.360*	.120	.003	.121	.598
	Being able to try the equipment	.588*	.131	.000	.328	.848
	Seeing others use the innovation	.579*	.129	.000	.324	.834
	Saves time	-.939*	.106	.000	-1.148	-.729
Seeing others use the innovation	Profitability	-1.079*	.109	.000	-1.294	-.864
	Ease of integration	-.982*	.117	.000	-1.214	-.751
	Difficulty of learning	-.219	.113	.056	-.444	.005
	Being able to try the equipment	.009	.105	.934	-.200	.218
	Positive environmental benefits	-.579*	.129	.000	-.834	-.324
	Saves time	-1.518*	.118	.000	-1.751	-1.284
Saves time	Profitability	.439*	.086	.000	.268	.610
	Ease of integration	.535*	.101	.000	.336	.734
	Difficulty of learning	1.298*	.111	.000	1.078	1.519
	Being able to try the equipment	1.526*	.121	.000	1.287	1.766
	Positive environmental benefits	.939*	.106	.000	.729	1.148
	Seeing others use the innovation	1.518*	.118	.000	1.284	1.751

*. Mean difference is significant at the .05 level.

Summary

The size of the farm and the age of the farmer are both significant predictors of the probability of a farmer adopting auto-steer in Mississippi. Geographic location and level of education were both included in the model but failed to indicate significant predictive ability. Among farmers who adopted auto-steer and those who did not, both groups ranked saving time and profitability as the most important and second most important factor in their decision. These are two very important factors in a farming enterprise. According to Castle et al (2016), precision agriculture innovations have been shown to provide numerous benefits in production agriculture with the potential for large economic impacts. These could mean an increase in efficiency which could lead to a higher profit. These are important considerations in order for a farmer to remain viable in an industry that is experiencing a decline in the number of farmers (USDA Census of Agriculture, 2017).

Extension's Role

There are many differences between farmers that include not only the variables in this study but also factors such as the personality of the farmer, history of the farming operation, and how involved they are in local educational programming efforts through the Extension Service. Researchers should consider including these additional factors as possible indicators of whether or not a farmer would choose to adopt a precision agriculture innovation.

Knowing which innovations are suitable for a particular farming operation requires investigation by the farmer. This provides an opportunity for the Extension Service to assist farmers in making the decision to adopt or not adopt. The role of the

Extension Service is unique in that it requires a working relationship with farmers. This relationship is built on trust. This trust is derived by Extension Agents providing unbiased research based information that is indicative and applicable to particular situations of farmers. In some instances, the decision to not adopt an innovation may be necessary. Knowing the reasons behind the farmers' decision making process can prove useful in directing them to the correct decision for their operation.

There are vast amounts of data that are currently being collected for precision agriculture innovations. These data are vital to the successful operation of a farm enterprise and is also very important to Extension in our role as a change agent. According to Rogers (2003) earlier adopters had more contact with change agents that did later adopters. With that being said, Extension Agents could focus their attention on those individuals who might not usually utilize our services. Within this role as a change agent, Extension has the opportunity to assist farmers in identifying which innovations to adopt. Realizing the differences among farmers and using available information, we can assist them from the standpoint of an unbiased observer. We can also model our educational and programming efforts in order to better serve those groups that might be identified as those with lower probabilities of adoption.

As mentioned previously, not every innovation will fit each farmer's operation in terms of financial obligation or profitability. Knowing how to provide the necessary information for farmers to make this decision can be difficult. Farmers have access to many types of information from many different sources. Many times, those sources have underlying motives for providing the information to farmers. In our role as a change agents, one limitation that must be overcome is deciphering the available information prior to the farmer making the final decision. Utilizing research-based information that has been tested and proven can help alleviate this limitation.

Implications

According to the data, there was no significant differences in adopting auto-steer between farmers in Delta counties or Hill counties. There was also no significant differences indicated by educational level on the probability of a farmer adopting auto-steer. This indicates that regardless of where a farming operation is located or the educational level of the farmer, the adoption of this auto-steer innovation is not significantly influenced by either. This information can prove important when developing an educational program involving a precision agriculture technology.

This analysis further indicated that as farm sized increased, the probability of a farmer adopting auto-steer increased significantly. This is an opportunity for Extension, in the terms of targeting smaller farmers who statistically would be less likely to adopt a precision agriculture technology. Many times we tend to focus our attention on those farms that are very large and successful when we need to be focusing on those smaller farms that possibly need more attention and training in order to change their perceptions and move themselves into one of the early adopter categories as mentioned by Rogers' (2003). It is also important to remember that Extension Agents need to maintain positive attitudes and provide technical and economic information during their educational programming efforts when promoting agriculture innovations (King & Rollins, 1995).

Age was another characteristic that had a significant effect on the probability of a farmer adopting auto-steer. The data indicate that as a farmer ages then their likelihood of adopting auto-steer decreases. This conclusion could be another opportunity where information can be made available to them in that could assist them in making the decision to adopt a precision agriculture technology, such as auto-steer, and if it could possibly pay benefits to them. Based upon the data, even though they may have chosen to not use auto-steer, this study shows that saving time and profitability are important reasons to them in making their decision. Highlighting these reasons could be the difference in whether or not a farmer makes the appropriate choice for his or her operation.

Recommendations

Further research in the field of precision agriculture should not be limited to only row crop farmers. Advances in the fields of beef production, forestry, and aquaculture could provide helpful insight into the reasons why producers adopt precision agriculture technologies.

Another area of precision agriculture that is rapidly expanding is the use of drones for field monitoring and data collection. There are numerous opportunities for these innovations to improve efficiency and profitability.

Extension should recognize the numerous opportunities available to farmers than can improve their efficiency and help them remain successful. This can be accomplished by providing the farmer with unbiased, research-based, timely information that will enable them to make correct decisions. Knowing which farmer could benefit from the adoption of an innovation can be difficult to ascertain. Not every farmer needs the latest innovation and it takes an objective overview to ascertain if an innovation is needed. We need to know where the farmer falls into Rogers' categories of adopters. Are they innovators or early adopters or do they fall into the category of the late majority or even a laggard? Information such as this can only come from a working relationship with the farmer that encompasses many aspects of their operation.

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APPENDIX A

PERMISSION EMAIL RECEIVED FROM UNIVERSITY OF TENNESSEE

DEPARTMENT OF AGRICULTURE ECONOMICS

Patrick,

I am happy we talked this morning and I wish you the best in your research.

I talked with Chris Boyer who now leads the Cotton Inc. Economics of Precision Farming Working Group. He and I agree that you can use and/or modify the questions in the 2001, 2005, 2009, and/or 2013 surveys listed below if you give attribution to our previous research.

I have also attached a list of creative achievements produced by the Working Group in which you will find a few articles and presentations dealing with auto-steer.

Dr. Roland K. Roberts
Professor, Department of Agriculture & Resource Economics
The University of Tennessee
2621 Morgan Circle
308B Morgan Hall
Knoxville, TN 37996-4518
Phone: 865-974-7482

APPENDIX B

PERMISSION FROM DR. JACKSON, DIRECTOR OF MSU EXTENSION SERVICE

TO ASK EXTENSION AGENTS FOR EMAIL LISTS OF FARMERS

Patrick:

I am supportive of your pilot study with some Agents. We do not have an official form, so my email permission will suffice. I assume you and Dr. Lemons have all the IRB approval you need for data collection, right? Thanks. GBJ

From: Poindexter, Patrick
Sent: Friday, July 08, 2016 7:36 AM
To: Jackson, Gary
Subject: Research process question

Dr. Jackson,

I had a quick question concerning my research project. With your permission, I'm planning on utilizing agronomy Extension agents to obtain physical addresses or email addresses for row crop producers across the state. I will then purchase the necessary envelopes, stamps, etc. in order to mail my survey instrument to these individuals. I will also utilize email in order to reach those farmers that would be willing to fill out an online Qualtrics© survey. Is there a standard process or form that I will need to follow or fill out in order to obtain written permission in order to accomplish this.

Please let me know how I should proceed with this process.

I hope you have a great weekend.

Talk to you soon.

Patrick

APPENDIX C

SURVEY INSTRUMENT

Final Data Collection

Q0 **Informed Consent Form for Participation in Research for Exempt Research*** **Title of Research Study:** Investigating the adoption of autosteer by row crop farmers in Mississippi **Researcher(s):** Dr. Laura Greenhaw, Mississippi State University; Patrick Poindexter, Mississippi State University **Procedures:** We would like to ask you to participate in a research study. If you agree to participate in this study, you will be asked to complete a survey that will take about 8 minutes to complete. **Questions:** If you have any questions about this research project, please feel free to contact Dr. Laura Greenhaw at laura.l.greenhaw@msstate.edu or Patrick Poindexter at p.poindexter@msstate.edu. **Voluntary Participation**: Please understand that **your participation is voluntary**. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. **You may discontinue your participation at any time** without penalty or loss of benefits. ***Please take all the time you need to read through this document and decide whether you would like to participate in this research study.*** If you decide to participate, your completion of the research procedures indicates your consent. Please keep this form for your records. *The MSU HRPP has granted an exemption for this research. Therefore, a formal review of this consent document was not required.

Page Break

Q1 1. What are the **primary COUNTY** and **STATE** in which your farm is located?

____

Q2 In what year were you born?

○ 1999 (1) ____

○ 1998 (2)

○ 1997 (3)

○ 1996 (4)

○ 1995 (5)

○ 1994 (6)

○ 1993 (7)

○ 1992 (8)

○ 1991 (9)

○ 1990 (10)

○ 1989 (11)

○ 1988 (12)

○ 1987 (13)

○ 1986 (14)

○ 1985 (15)

○ 1984 (16)

○ 1983 (17)

○ 1982 (18)

○ 1981 (19)

○ 1980 (20)

○ 1979 (21)

○ 1978 (22)

○ 1977 (23)

○ 1976 (24)

○ 1975 (25)

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○ 1970 (30)

○ 1969 (31)

○ 1968 (32)

○ 1967 (33)

○ 1966 (34)

○ 1965 (35)

○ 1964 (36)

○ 1963 (37)

○ 1962 (38)

○ 1961 (39)

○ 1960 (40)

○ 1959 (41)

○ 1958 (42)

○ 1957 (43)

○ 1956 (44)

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○ 1943 (57)

○ 1942 (58)

○ 1941 (59)

○ 1940 (60)

○ 1939 (61)

○ 1938 (62)

○ 1937 (63)

○ 1936 (64)

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○ 1934 (66)

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○ 1932 (68)

○ 1931 (69)

○ 1930 (70)

○ 1929 (71)

○ 1928 (72)

○ 1927 (73)

○ 1926 (74)

○ 1925 (75)

○ 1924 (76)

○ 1923 (77)

○ 1922 (78)

○ 1921 (79)

○ 1920 (80)

○ 1919 (81)

Q3 What crops do you grow? (Mark all that apply)

- ☐ Corn (1)
- ☐ Cotton (2)
- ☐ Milo (3)
- ☐ Peanuts (4)
- ☐ Rice (5)
- ☐ Soybeans (6)
- ☐ Wheat (7)
- ☐ Other (8) ____________________

Q4 How many years have you been farming?

____

Q5 How many acres do you farm?

____

Q6 What is the highest level of education that you've attained?

- Some High School (1)
- High School Diploma/GED (2)
- Associate's Degree(including occupational degrees) (3)
- Bachelor's Degree (4)
- Graduate/Professional Degree (5)
- Some College (6)
- Some Graduate School (7)

Q26 Do you use electronic devices in farm management decisions outside of field work (ex. laptop, tablet, smartphone, handheld GPS, etc.)?

- Yes (1)
- No (4)

Skip To: Q8 If Q26 No

Q7 What devices do you use to make farm management decisions? (check all that apply)

- ▢ Laptop (1)
- ▢ Tablet (iPad, XOOM, Kindle) (2)
- ▢ Smartphone (3)
- ▢ Handheld GPS (4)
- ▢ Other (Please list) (5) ____________________
- ▢ Soil Moisture Meters (6)

Q8 Do you utilize auto-steer on any piece of your farm equipment

- ○ Yes (1)
- ○ No (2)

Skip To: Q10 If Q8 Yes

Q9 Please rate the following factors based upon importance in your decision to NOT USE auto-steer.

	Not Important at all (1)	Of Little Importance (2)	Of Average Importance (3)	Very Important (4)	Absolutely Essential (5)
Profitability (1)	○	○	○	○	○
Autosteer can be integrated into your existing equipment (2)	○	○	○	○	○
Difficulty of learning how to use autsteer (3)	○	○	○	○	○
Being able to try autosteer before purchasing it (4)	○	○	○	○	○
Autosteer can have positive environmental benefits (5)	○	○	○	○	○
Beeing able to see others use autosteer before purchasing it (6)	○	○	○	○	○
Autosteer saves time (7)	○	○	○	○	○

Skip To: End of Survey If Q9(Profitability) Is Displayed

Q10

For which field operations do you use auto-steer? (Select all that apply)

- ▢ Tillage (1)
- ▢ Planting (2)
- ▢ Spraying (3)
- ▢ Cultivating (4)
- ▢ Harvesting (5)
- ▢ Other (please list) (6) ____________________

Q11 In what year did you first implement auto-steer?

- ○ 2017 (1)
- ○ 2016 (2)
- ○ 2015 (3)
- ○ 2014 (4)
- ○ 2013 (5)
- ○ 2012 (6)
- ○ 2011 (7)
- ○ 2010 (8)
- ○ 2009 (9)
- ○ 2008 (10)
- ○ 2007 (11)
- ○ 2006 (12)
- ○ 2005 (13)
- ○ 2004 (14)
- ○ 2003 (15)
- ○ 2002 (16)

○ 2001 (17)

○ 2000 (18)

○ 1999 (19)

○ 1998 (20)

○ 1997 (21)

○ 1996 (22)

○ 1995 (23)

○ 1994 (24)

○ 1993 (25)

○ 1992 (26)

○ 1991 (27)

○ 1990 (28)

○ 1989 (29)

○ 1988 (30)

○ 1987 (31)

○ 1986 (32)

○ 1985 (33)

○ 1984 (34)

○ 1983 (35)

○ 1982 (36)

○ 1981 (37)

○ 1980 (38)

Q12 Please rate the following factors based upon importance in your decision to use auto-steer.

	Not Important at all (1)	Of Little Importance (2)	Of Average Importance (3)	Very Important (4)	Absolutely Essential (5)
Profitability (1)	○	○	○	○	○
Auto-steer can be integrated into your existing equipment (2)	○	○	○	○	○
Difficulty of learning how to use auto-steer (3)	○	○	○	○	○
Being able to try auto-steer before purchasing it (4)	○	○	○	○	○
Auto-steer can have positive environmental benefits (5)	○	○	○	○	○
Beeing able to see others use auto-steer before purchasing it (6)	○	○	○	○	○
Auto-steer saves time (7)	○	○	○	○	○

Q13 Has the use of auto-steer met your expectations?

- ◯ Has not met my expectations at all (1)
- ◯ Somewhat met my expectations (2)
- ◯ Has fully met my expectations (3)
- ◯ Has exceeded my expectations (4)

Q14 Have you attended an MSU Extension educational event or presentation regarding precision agriculture (variable rate technology, GPS soil/yield mapping, guidance system, etc)?

- ◯ Yes (1)
- ◯ No (2)

Q16 Have you used MSU Extension publications to obtain precision agriculture information?

- ◯ Yes (1)
- ◯ No (2)

Q17 To have your name removed from further reminders to complete this survey, please provide your email address in the space provided.

____

End of Block: Default Question Block

APPENDIX D

APPROVED UIA REQUEST FORM

APPROVED
By HRPP at 10:38 am, Jan 11, 2018

MISSISSIPPI STATE UNIVERSITY HUMAN RESEARCH PROTECTION PROGRAM	Unaffiliated Investigator Agreement Approval Request Form Version 09.08.2017

This form should be used to petition the MSU IRB to serve as IRB of Record for Unaffiliated Investigators who are engaged in human subjects research with MSU in accordance with HRPP Operations Manual on Collaborative Research.

Principal Researcher/Investigator: Laura L Greenhaw

Study Title: Investigating the adoption of autosteer by row crop farmers in MS

IRB Study number (if assigned): 17-683

In one paragraph, briefly describe the purpose of the study:

The purpose of this study is to investigate Mississippi farmers' motivations and characteristics with regard to adoption of technology in their farming operation, specifically autosteer. This research will provide valuable insight for MSU Extension in terms of understanding why farmers adopt or do not adopt farming practices and technologies.

Provide justification for the need to engage outside investigators in the conduct of the study:

Dr. Herndon is a current committee member on Patrick Poindexter's doctoral committee. This research is being conducted by Patrick for his dissertation under my advisement. Dr. Herndon recently retired from MSU, however, he has been retained as a committee member for this research due to his extensive knowledge of and experience with agriculture and MSU extension.

Briefly describe the procedures that will be conducted by Unaffiliated Investigators. Note: all procedures must be fully described in myProtocol application or added via an amendment.

With regard to the research, Dr. Herndon has assisted with research design and methodology and will assist with interpretation of results. He will not be involved in any data collection.

How will Unaffiliated Investigators be identified and chosen for engagement in study activities? For example, describe salient characteristics (such as collaborating institutional affiliation, position, qualifications, etc.) of those who will be asked to assist in conducting the study.

Dr. Herndon was selected as a committee member on this dissertation research due to his extensive knowledge of agriculture, statistics, quantitative research methodologies, and MSU extension.

How many Unaffiliate Investigators will you require in the conduct of this study? 1

Describe how you will direct and appropriately supervise all of the research activities to be performed by the collaborating Unaffiliated Investigator(s).

As previously stated, Dr. Herndon will assist with interpretation of results as a member of the dissertation committee. All committee activities will be directed and supervised by me during committee meetings.

Principal Investigator: Laura L Greenhaw Digitally signed by Laura L Greenhaw Date: 2018.01.04 12:12:52 -06'00' Date:

Unaffiliated Investigator Agreement Approval Request Form