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Factors Influencing Farmers' Utilization of Auto-Guidance Technology in Northern Utah

Thomas A. Bleazard
Utah State University

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FACTORS INFLUENCING FARMERS’ UTILIZATION OF AUTO-GUIDANCE TECHNOLOGY IN NORTHERN UTAH

by

Thomas A. Bleazard

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Agricultural Systems Technology
(Agricultural Extension Education)

Approved:

Michael L. Pate
Major Professor

Royce Hatch
Committee Member

Clark Israelsen
Committee Member

Rebecca G. Lawver
Committee Member

Mark McLellan
Vice President for Research and Dean of the School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2015
ABSTRACT

Factors Influencing Farmers’ Utilization of Auto-guidance Technology in Northern Utah

by

Thomas Bleazard, Master of Science

Utah State University, 2015

Major Professor: Michael L. Pate
Department: Agricultural Systems Technology and Education

The purpose of this descriptive-correlation study was to examine the variables associated with Northern Utah farmers’ adoption of auto-guidance technologies in alfalfa and corn silage production and determine training preferences. Participants in this study engaged in an experiential training session utilizing an auto-guidance system comparable to those available for use on their own farm. A survey was administered to identify auto-guidance technology adoption and farmers’ preferences for related training. The majority of participants reported being male (f = 56, 98.2%). Half of the participants in this study (50.8%) indicated using auto-guidance technology in some form in their farming practices. Most attendees used auto-guidance technology with tractors (36.1%) and self-propelled windrowers (32.8%). Agricultural equipment businesses and Extension agents should help non-users to embrace new technology by using implementation statistics that include peer usage and management benefits.

(58 pages)
Factors Influencing Farmers’ Utilization of Auto-guidance Technology in Northern Utah

by

Thomas Bleazard, Master of Science

Utah State University, 2015

Few studies have documented the use of auto-guidance technologies in the western United States. This study sought to discover farmers’ training preferences and what drives adoption of auto-guidance systems in northern Utah. A presentation of auto-guidance systems was made to crop school attendees. Afterwards an auto-guidance simulator was used to demonstrate to participants how these systems worked and let them engage in an experiential learning experience with laptops. A survey was administered to collect information on farmers’ training preferences and use of auto-guidance technologies. Results of the survey showed that farmers have a large interest in learning about auto-guidance technologies, particularly in tractors. The findings can assist Extension and change agents in the geographic area to understand farmers’ training preferences and to help farmers overcome barriers to adoption of auto-guidance technology. Extension and change agents should use hands-on training to teach producers about auto-guidance technologies.
ACKNOWLEDGMENTS

I would like to give special thanks to my advisor, Dr. Michael Pate, who guided me through this process. I would like to thank the rest of my committee members, Dr. Rebecca Lawver, Mr. Clark Israelsen, and Mr. Royce Hatch, for all of their help and expertise whenever I needed it through this process. I would like to give special thanks to the Utah State University Extension service for letting me present at the Cache county crop school and the Weber, Davis, and Morgan county crop schools. I also appreciate the participants who listened to the presentation and filled out surveys to make this study possible. I would also like to give special thanks to my wife, Jill, and children, Caleb, Alina, Bridget, and Mason, for bearing with me and supporting me. I could not have done this without all of you.

Thomas Bleazard
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CHAPTER I
INTRODUCTION

Operation of agricultural machinery can be an extremely daunting task for the operator. With the increase size of machinery to improve efficiency, operators must be precise in steering equipment to prevent damage to crops or to reduce overlap and skips when applying agrochemicals. Managing this task generates increased fatigue on the operator, which can compound poor performance over longer periods of time in the field (Heraud & Lange, 2009). Willrodt's (1924) steering system was developed to guide tractors using furrows was one of the first attempts to overcome operator fatigue and improve operation precision (US Patent No. 150670, 1924). Heraud and Lange (2009) concluded that not until the 1990s, with the arrival of the Global Positioning System (GPS), were there sufficient technologies available to meet the needs demanded by agriculturist.

The variety and capabilities of this technology is ever increasing. Global Positioning Systems (GPS), variable rate technology, and yield monitoring are a few of the technologies that aid agriculturalists with improving the efficiency of their machinery. Additional technologies, such as remote sensors and Geographic Information Systems (GIS) mapping serve as management tools that assist farmers in making decisions regarding field inputs (John Deere, 2000).

GPS initially became more popular in the mid-1990s (Heraud & Lange, 2009). Reid, Zhang, Noguchi, and Dickson (2000) stated the potential of vehicle automation has increased with improvement of GPS technologies. Automation using GPS changed by two major events. First, GPS has advanced systems in providing position information that
provides for a vehicle guidance system. Next, GPS technology has placed equipment manufacturers and farmers within reach of vehicle automation (Reid et al., 2000).

The use of precision agricultural technology on farms across the United States has been slow due to barriers such as cost and lack of education (Winstead et al., 2010). An article written by Kitchen, Snyder, Franzen, and Wiebold (2002) states that the lack of enthusiasm to implement precision agriculture relies on access to knowledgeable change agents, the cost and availability of education and precision agriculture products. Surveys report that large acre farms are more apt to adopt precision agriculture technologies than a small acre farms (Winstead, et al., 2010). Banerjee et al. (2008) concluded that farm size, land quality, age, education, use of multiple precision agriculture technologies, computer use, income, and state were all factors that determined adoption of precision agriculture technologies. Similarly, in a study by Larson, Roberts, English, Larkin, Marra, Martin, Paxton, & Reeves (2008), farmers age, education and farm size were prediction of the decision to use satellite imagery to make management decisions. The Winstead et al. (2010) study stated that if a farmer was using GPS guidance with a light bar to steer the equipment, it does not mean that they will adopt automated guidance systems or other systems in precision agriculture.

Lavergne (2004) explained that Extension agents play an important role in the decision of the producer to adopt technology innovations. It seems that monetary factors have had a heavy influence on adoption of precision agriculture.

Despite the documented advantages from incorporating auto-guidance technologies on the farm, the adoption of auto-guidance technologies shows to vary depending on region (Daberkow & McBride, 2003). Kitchen et al. (2002) noted that there
was a lack confidence in precision agriculture. This lack of confidence makes it difficult for change agents to get farmers to implement auto-guidance technologies in their farming practices. Kitchen et al. (2002) recommended that farmers need hands-on experience when learning to use precision agriculture products. Diekmann and Batte (2010) also reported that around two-thirds of 1,163 farmers surveyed strongly agreed that there is lack of educational training in precision agriculture of which auto-guidance is a part. Kitchen et al. (2002) described that training individuals to use precision agriculture technologies is complex and recommended that an understanding of explicit producer needs is necessary to provide product development and direction for training programs. Farmers can gain confidence as they experience auto-guidance technologies, helping them overcome barriers to entry that are too great to overcome on their own. This can close the gap in what producers know about auto-guidance technologies and what they want to know helping them to have their educational needs filled.

While there have been many studies completed that have surveyed farmers about adoption of precision agriculture technologies, these studies have all been completed in the eastern United States (Diekman & Battle, 2010; Jenkins, 2009; Kitchen et al., 2002; Lavergne, 2004; Winstead et al., 2010). There are few studies documenting the adoption and utilization of precision agriculture technologies in the western United States especially those primarily producing forages such as alfalfa and corn silage.
Purpose of the Study

The purpose of this study was to examine the variables associated with Northern Utah Cooperative Extension Crop School attendees’ decision to use auto-guidance technology in alfalfa and corn silage production and determine training preferences.

Research Objectives

This study was guided by the following research objectives:

1. Describe the current level of use of auto-guidance systems among Cooperative Extension Crop School attendees in Northern Utah.
2. Identify Crop School Attendees’ perceptions of auto-guidance systems.
3. Describe Crop School Attendees’ auto-guidance technologies training preferences.
4. Identify Crop School Attendees’ perceived attributes leading to the adoption of technology innovations.
5. Determine the association between selected variables and decision to use auto-guidance.

Significance of the Study

This study provides Extension specialists and private precision agriculture sales personnel information about auto-guidance usage by Northern Utah farmers. The information describes producers’ perceptions of auto-guidance technology as well as identifying variables that influence decisions to use this technology. This study identified variables associated with auto-guidance use.
**Definition of Terms**

The following definitions of terms are provided to clarify terminology used throughout the study.

- **Automatic Guidance:** a system that uses controllers to steer the vehicle along a guideline instead of a manual steering system (Heraud & Lange, 2009).
- **Geographic Information Systems (GIS):** a system, usually computer based, for the input, storage, retrieval, analysis, and display of geographic data (John Deere, 2010).
- **Global Positioning Systems (GPS):** a positioning system using satellites and radio receivers that gives the receiver the approximate position (John Deere, 2010).
- **Precision Agriculture:** electronic monitoring and control applied to agriculture, including site-specific application of inputs, timing of operations, and monitoring of crops and employees (Barnerjee et al., 2008).
- **Remote Sensing:** the act of detection and/or identification of objects, series of objects, or landscape without coming in direct contact with the object (John Deere, 2010).
- **Variable Rate Technology:** adjustments to the amount of cropping inputs such as seed, fertilizer and pesticides to match conditions in a field (John Deere, 2010).
- **Yield Monitoring:** collecting data on-the-go across a field to provide a spatial representation of yield performance (Kitchen et al., 2002).
Northern Utah Agriculture

Production agriculture is vital to the economies of intermountain states within the great basin region of the United States (Olsen, 2013). For example, production agriculture and the associated processing sector accounted for 14.1% of Utah’s 2011 gross state output (Ward, Jakus, & Coulibaly, 2013). The value of production agriculture accounted for $3.8 billion in total economic output (Ward et al., 2013). The USDA (2014) reports that in 2014 there were 520,000 acres of hay harvested averaging 3.9 tons/acre and 45,000 acres of silage corn planted that averaged 22 tons/acre across the state of Utah. Alfalfa crop production in Utah was reported to generate revenue of just over $385,320,000 (USDA, 2014). Cache and Box Elder counties harvested a little more than 19% of Utah’s 660,000 acres dedicated to hay production in 2012 (USDA, 2013).

Cache and Box Elder counties are among the most agriculturally productive in the state of Utah (USDA, 2013). The average farm size reported by the USDA (2013) for Cache county is 221 acres and Box Elder county average farm size was 948 acres. In 2012, there were 1,217 farms in Cache county and 1,235 farms in Box Elder County (USDA, 2013).

These economic numbers make it evident that there is a large amount of agriculture production dedicated to these crops within these counties which plays a significant role in the state economy. By reducing the cost of alfalfa and corn silage production using efficient auto-guidance technologies to improve machinery efficiencies
may be of high interest to farmers and ranchers in this area. These technologies improve efficiency by reducing overlap and skips when applying agrochemicals. These applications account for a high portion of input costs for crop production. As prices increase for inputs such as fuel and fertilizer, many producers are investigating methods of production to improve efficiencies. It has been documented that these technologies can save producers time and money by reducing the amount of crop inputs and equipment down time (Diekmann & Batte, 2010).

**Need for Efficient Production Technologies**

There are many studies have focused precision farming technologies that include auto-guidance technologies. These studies have examined adoption factors, educational needs of producers, and integration into college and Extension courses (Adrian, Norwood, & Mask, 2005; Banerjee et al., 2008; Daberkow & McBride, 2003; Diekmann & Batte, 2010; Johnson, 2007; Kitchen et al., 2002; Larson et al., 2008; Lavergne, 2004; Shannon, 2012; Winstead et al., 2010). However, none of these studies have been completed in the western United States. These studies have not combined the education of producers with adoption practices and have included a demonstration as part of the teaching for the study.

According to the USDA National Agricultural Statistics Service (USDA, 2013), U.S. farms spent an average of $162,743 on total expenditures in 2010. For all 2.2 million farms in the U.S. a total of $15.4 billion was spent on fuel, an average of $7,124 per farm. For crop farms, the combined crop input cost was $55.5 billion dollars, with a total area of 325 million acres planted. This equates to an average input cost of approximately $170
per acre. The combined crop input includes chemicals, fertilizers, and seeds. Chemical expenditure was an average of $6,337 per farm or approximately $4 per acre (USDA, 2013). Being able to save fuel and chemicals by being more efficient on each application would allow these small farms to be more profitable. In Utah there are 16,400 farms reported to the USDA, with around 11 million acres in farmland. The average of approximately 677 acres per farm. So, for the average farm size in Utah, the farmer is spending $115,090 ($170 per acre x 677 acres) per year on input costs. For farming operations, the money saved would be welcome. The investment of equipment is often judged by its break-even price: a calculation that shows the more the equipment is used, the more its cost per acre is dispersed (Field & Solie, 2007).

Another factor that auto-guidance technologies influence is safety. Driving equipment for long hours generates increased fatigue on the operator, which can compound poor performance in the application of field inputs such as fertilizer (Heraud & Lange, 2009). Auto-guidance technologies allow the driver to concentrate on other tasks instead of trying to complete multiple tasks at the same time. These auto-guidance technologies can also reduce the environmental risk associated with farming by optimizing the amount of any input to any one part of the field (Atherton, Morgan, Shearer, Stombaugh, & Ward, 1999).

Despite the documented advantages, there have not been any studies completed in regarding the use in alfalfa and corn silage production of auto-guidance technology in northern Utah. Lack of research raises the question of why farmers and ranchers are or are not using precision agriculture technologies in northern Utah. Identifying the key variables that have been cited as affecting the diffusion of agricultural technologies such
as auto-guidance would be beneficial to Extension agents of the intermountain west region (Kitchen et al., 2002).

**Diffusion of Innovation and Change Agents**

The theoretical framework for this study was constructed from the tenets of diffusion of innovation theory, experiential learning theory, and tinkering self-efficacy. In the diffusion of innovation theory, Rogers (2003) explained that the diffusion process is “the process by which an innovation is communicated through certain channels over time among the members of a social system” (p. 5). Communication channels were described by Rogers’ as being a way for people to communicate and share ideas as they develop new ideas. Rogers (2003) explained that these channels are mass media, interpersonal, localite, cosmopolite and interactive. Rogers (2003) defined these as:

1. Mass media channels- are a way to reach a large population of individuals quickly like television, radio and newspaper.
2. Interpersonal channels: face-to-face interaction, such as at a conference.
3. Localite channels: channels that are inside of a social system.
4. Cosmopolite channels: sources outside of a social system.
5. Interactive channels: communication via the internet like social media sites.

These communication channels can be used to reach out to farmers that have yet to adopt auto-guidance in their farming practices. Rogers (2003) informed us that mass media and cosmopolite channels are more important for early adopters and interpersonal and localite channels are of higher importance for later adopters. Using this information, we can know where to utilize established communication channels and trusted change
agents. This helps us understand more about the factors affecting adoption of auto-guidance technologies. Using channels like newspaper, radio, and social media may reach a wide variety of farmers quickly to inform them on auto-guidance technology.

Change agents as described by Gladwell (2002) come in three forms--Connectors, Mavens, and Salespeople. Gladwell (2002) described connectors as people who know everyone, mavens as people who know about everything, and salespeople as persuaders. Lavergne’s (2004) study of adoption of precision agriculture identified dealers as top change agents and Extension services as the second frequently used change agents for precision agriculture information. Using these types of change agents to inform farmers of the training may help to spread the information about this study quickly and get farmers out to hear the information. These change agents could serve as critical points of contacts for venues to present auto-guidance information.

**Experiential Learning Theory**

Understanding the needs that producers have in the diffusion of innovation process is a key factor in adoption of innovation. Rogers (2003) identified trialability as one key attribute of innovation to adoption. Trialability is the ability to use an innovation before fully adopting it. This could be comparable to test driving a GPS system before you buy it. This concept of trialability can be tied in with experiential learning theory. Experiential learning as explained by Kolb (1984) is a learning process by which doing creates knowledge. Experimentation with new ideas and concepts plays a central role in making the learning process more meaningful for the individual (Kolb, 1984). This applies to this study by giving the participants the opportunity to use an auto-guidance
simulator at a crop school demonstration to help them to have a hands-on experience. Salle, Edgar, and Jones (2013) indicate that experiential learning helps the learner to grasp the concept and allows them to synthesize information they will need to take ownership of their learning. In the final stage of learning, it is important that learners take the information that they learn and reflect while making their own conclusions (Salle et al., 2013).

The experiential learning theory when applied to auto-guidance technology training will help learners to familiarize themselves with auto-guidance and makes them less fearful of these systems (Adrian et al., 2005; Barnerjee et al., 2008; Daberkow & McBride, 2003; Kitchen et al., 2002; Mask, Adrian, & Norwood, 2005). Through the experience of using a simulator, attendees may understand these systems better and be more willing to adopt them because of their simulator experience.

**Tinkering Self-efficacy**

The idea of tinkering self-efficacy refers to the comfort, competence, and experience of manual tasks that one has. Tinkering self-efficacy explains one's ability to engage in tasks that require elements like constructing, modifying, repairing, assembling, disassembling, and manipulating devices and components (Baker & Krause, 2007). This idea suggests that producers may prefer learning about auto-guidance technology through hands-on experiences rather than informational sessions typically seen in farm trade shows.

Tinkering self-efficacy can be used in this study by giving the attendees hands on experience with an auto-guidance simulator. Producers were able to use touch screen
laptop computers with a simulator of an auto-guidance unit installed on it. If taught using this method, producers should be more likely to prefer this type of training with auto-guidance technology.
CHAPTER III
METHODOLOGY

The purpose of this descriptive-correlation study was to examine the variables associated with Northern Utah farmers’ adoption of auto-guidance technologies in alfalfa and corn silage production and determine training preferences. This chapter discusses the research techniques and procedures used to achieve the purpose of the study.

Design

A cross-sectional survey was used to gather descriptive information on farmers use and perceptions of auto-guidance in agriculture. The study design was descriptive-correlational. The study used a directly administered questionnaire paper-based survey to give questions to the population.

Participants

The target population for this study was Utah Cooperative Extension crop school attendees over the age of 18 who primarily engage in alfalfa and corn silage production in Northern Utah. Approximately 99 individuals attended the crop schools hosted by Utah State University (USU) Extension in northern Utah at two different locations and times. A total of 61 participants completed the survey for a response rate of 62%.

Instrument

The instrument for this study was designed and modified from a review of literature (Lavergne, 2004; Winstead et al., 2010). A panel of experts reviewed content validity. The instrument was pilot tested with USU College of Agriculture and Applied
Science students who were currently taking a course in a related field. Survey questions were examined and modified to increase the instruments reliability and validity based on expert suggestions and the pilot test (Sallee et al., 2013). Twenty-nine students participated in the pilot study. The students participated in two training sessions as outlined in the training program section. Training sessions were separated by one week to check the reliability of the instrument using test-retest.

Reliability estimates were calculated using intra-class correlation coefficient for questions asking respondents about their perceptions (Bartko, 1991; Yen & Lo, 2002). A coefficient value between .75 to 1.00 has been considered an “excellent” reliability estimate (Cicchetti, 1994). It was assumed that demographic questions did not elicit demands for considerable time, thought, nor variation and therefore was considered to pose no reliability risks (Dillman, 2000). The instrument was composed of three sections. The first section contained demographic questions to determine if participants used auto-guidance technology. Respondents were able to answer the questions using multiple responses by checking all that apply. Other questions were used to determine the type of equipment used with auto-guidance and production demographics. The second section of the questionnaire asked participants to rank the training presentation components with one being most effective and three being least effective. An additional question asked participants to select the adopter category definition that best described them and their motivation to adopt new technology. This question had an intra-class correlation coefficient of .91. The third section contained questions eliciting perceptions on the use and versatility of auto-guidance technology. Participants responded using a 5-point Likert scale of 1 = Strongly Disagree through 5 = Strongly Agree. These questions were designed
to gather participants’ level of agreement to the usability of auto-guidance technology to improve farm management ($\alpha = .91$) and safety ($\alpha = .84$). Participants were also asked about their perceived auto-guidance technology training needs ($\alpha = .89$). See Appendix A for a copy of the instrument.

**Training Program**

A twenty-five minute information session on auto-guidance technology was provided using a lecture and demonstration format. The second part of the training provided participants with a demonstration on using a simulator for the applied portion of the presentation. During the applied portion, producers were asked to tinker with an auto-guidance simulator that was installed on Lenovo B50 touch screen laptop computers. Following the tinkering, participants were given a post-test instrument to identify adoption levels, perceived training, preference, and demographic questions.

The auto-guidance technology presentation included information on how systems work, advantages and disadvantages, cost, and uses for each type of system. The presentation objective is to inform the producer of the different systems available and to determine the effect of the material on the producers’ perceptions of auto-guidance systems in agriculture. (Training Program Outline can be found in Appendix B.)

**Data Collection**

Data collection was accomplished through a paper-based survey following the training seminar. Data were entered into IBM SPSS 20 for analysis. The SPSS file was reviewed for data entry errors by running frequencies distributions. No errors were detected.
Data Analysis

Frequencies, percentages, means and standard deviations were reported for demographic variables. Descriptive statistics were used to describe the results of this study. Medians were used to report centered on selected variables. Range and standard deviation were used to report descriptive and variance of variables. A chi-square test of independence was used to determine the association between decision to use auto-guidance and selected variables. Selected variables included education level, diffusion of innovation category, and size of farm. Size of farm was classified using the USDA NASS (2014) report to find mean farm size of 608 acres. An independent $t$ test was used to determine if there was any significance in age between users and non-users.
CHAPTER IV
RESULTS/FINDINGS

Objective One: Describe the current level of adoption of auto-guidance systems among Northern Utah crop school attendees.

A total of 99 participants attended both crop schools. The majority of participants reported being male ($f = 56, 98.2\%$). There was only one participant that reported their gender as female. The average reported age of participants was 49 ($SD = 14.16$). Individuals were classified as users if they indicated using auto-guidance with agricultural equipment. If participants indicated that they did not using auto-guidance, they were classified as non-users. A total of 31 (50.8\%) of the 61 surveys collected from the two crop schools indicated using an auto-guidance technology. Weber, Davis, and Morgan crop school, 11 surveys were completed and collected from the crop school. The Cache County crop school had 50 surveys completed and returned. Thirty-one participants reported using an auto-guidance technology. A total of 30 participants from indicated they did not use auto-guidance technology.

The range of acres reported by all participants was from zero to 4500 acres. The median acreage reported by participants was 400 acres. The mean acreage reported by all participants was 648.61 acres. Non-user participants reported farmed acreage ranged from zero to 1500 acres farmed. The median acreage reported was 160 acres and mean acreage found was 325.35 acres for non-users. The range was 50 to 4500 acres farmed by users of auto-guidance technology. The median acreage farmed by users was 600 acres while the mean acreage was 934.58 acres. Six (19.4\%) auto-guidance users indicated that
the majority of their cash receipts came from the production of forage. The production type that was least reported was vegetables with one (3.2%) of the users reporting this.

Participants were asked to indicate which auto-guidance system they use on their agricultural equipment. A detailed list was provided to participants to select from (see Table 1). The “other” response option was provided to allow participants to list a system that was not provided. A variety of auto-guidance systems were listed by respondents. The system used by the most individuals was Trimble® EZ-Steer™ \( (f = 8, 13.1\%) \). Nine individuals selected “other system.” These systems included Raven, Raven Cruiser 2, Raven Viper Pro, Topcon, Ag Leader Steer Command and TracMap guidance systems.

Participants were asked to indicate which type of equipment was used with auto-guidance technology. A list of equipment was provided for participants to select from (see Table 2). An “other equipment” response was provided to allow participants to list equipment not provided in the list. There were 22 respondents (36%) who used auto-guidance with their tractors. Eight individuals (13%) indicated using an auto-guidance system with self-propelled windrowers and only one individual reporting using an auto-guidance system with a forage harvester. Other vehicles that farmers reported auto-guidance use with were ATV \( (f = 1, 1.6\%) \), UTV \( (f = 1, 1.6\%) \) and fertilizer spreaders \( (f = 2, 3.2\%) \).

Table 1

<table>
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<tr>
<th>Auto-guidance System</th>
<th>( f )</th>
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<tbody>
<tr>
<td>Trimble® EZ-Steer™</td>
<td>8</td>
<td>13.1</td>
</tr>
<tr>
<td>Case IH AFS Accuguide™</td>
<td>6</td>
<td>9.8</td>
</tr>
</tbody>
</table>
Objective Two: Identify crop school attendees’ perceptions of auto-guidance systems.

Participants were asked what crop production type would benefit the most from using auto-guidance technology. A total of 31 (50.8%) participants indicated that alfalfa production would benefit most from using auto-guidance technology. Corn had a total of 25 (41%) participants say that it would benefit from auto-guidance usage. Beans was chosen by only two (6.5%) of the 31 users of auto-guidance technology as a crop that would greatly benefit from the use of this technology. Participants indicated other crops that would benefit from auto-guidance technology. These crops included safflower, orchard, onions, onions/pumpkins/tomatoes, barley and high value vegetable crops. A non-crop variable reported was land elevation.

Table 2

<table>
<thead>
<tr>
<th>Equipment</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimble® Autopilot™</td>
<td>5</td>
<td>8.2</td>
</tr>
<tr>
<td>Ag Leader® ONTRAC3™</td>
<td>5</td>
<td>8.2</td>
</tr>
<tr>
<td>Trimble® EZ-Pilot™</td>
<td>4</td>
<td>6.6</td>
</tr>
<tr>
<td>John Deere Auto Trac™</td>
<td>4</td>
<td>6.6</td>
</tr>
<tr>
<td>Ag Leader® Geosteer®</td>
<td>4</td>
<td>6.6</td>
</tr>
<tr>
<td>Ag Leader® Paradyme®</td>
<td>3</td>
<td>4.9</td>
</tr>
<tr>
<td>New Holland Intellisteer™</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Non-Users</td>
<td>30</td>
<td>49.2</td>
</tr>
</tbody>
</table>

Note. Participants were asked to check all that applied.
Participants were asked to indicate their level of agreement that auto-guidance would be useful for accomplishing farm business management goals using a 5-point Likert scale ranging from 1 = *Strongly Disagree* through 5 = *Strongly Agree*. Literature cited that these goals were the most commonly used justification for adoption of auto-guidance technology (Kitchen et al., 2002; Lavergne, 2004; Winstead et al., 2010). When constructing a summated mean for table 3, statistics show a mean of 4.18 for table 3. This indicates that participants have a positive attitude towards auto-guidance technologies usefulness. Table 3 shows the percentage and frequencies for each management goal. The majority of participants \( f = 29, \ 47.5\% \) strongly agreed that auto-guidance would reduce input cost such as fertilizer and fuel cost. The majority of participants agreed that auto-guidance could help increase their yield per acre \( f = 28, \ 46\% \), increase their ability to farm more acres \( f = 32, \ 60\% \), increase ability to collect data for future management decisions \( f = 26, \ 47\% \), and increase machine capacity \( f = 24, \ 45\% \) (Table 3).

<table>
<thead>
<tr>
<th>Tractors</th>
<th>22</th>
<th>36.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprayers</td>
<td>20</td>
<td>32.8</td>
</tr>
<tr>
<td>Self-propelled Windrowers</td>
<td>8</td>
<td>13.1</td>
</tr>
<tr>
<td>Combines</td>
<td>5</td>
<td>8.2</td>
</tr>
<tr>
<td>Forage harvesters</td>
<td>1</td>
<td>1.6</td>
</tr>
</tbody>
</table>

*Note. Participants were asked to check all that applied.*
<table>
<thead>
<tr>
<th>Topic</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing input cost (fuel, fertilizer, etc.) ((n = 55))</td>
<td>29</td>
<td>22</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Collecting data for future management decisions ((n = 55))</td>
<td>23</td>
<td>26</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Increasing machine capacity ((n = 53))</td>
<td>18</td>
<td>24</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Increase the ability to farm more acres ((n = 53))</td>
<td>14</td>
<td>32</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Increasing yield per acre ((n = 55))</td>
<td>14</td>
<td>28</td>
<td>10</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note. SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SA= Strongly Disagree*

Participants were asked to indicate their level of agreement that auto-guidance would be beneficial for accomplishing safety goals using a 5-point Likert scale ranging from 1= *Strongly Disagree* through 5= *Strongly Agree*. Literature cited the listed safety benefits in Table 4 as commonly used for justification to use auto-guidance technology (Diekmann & Battle, 2010; Lavergne, 2004). When constructing a summated mean for table 4, statistics show a mean of 3.92 for Table 4. Participants show less enthusiasm for increased safety benefits of auto-guidance technology than with usefulness. The majority of participants \((f = 29, 53\%)\) agreed that auto-guidance systems would assist with increasing an operators’ ability to monitor towed equipment. Operator fatigue was the next highest perceived safety benefit from using auto-guidance systems. There were seven individuals \((12.7\%)\) that disagreed to strongly disagreed auto-guidance technology would assist operators with avoiding in-field obstacles.

Table 4.
Safety Benefits of Auto-guidance \((n = 55)\)

<table>
<thead>
<tr>
<th>Topic</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing operators’ ability to monitor towed equipment (\text{baler, plow, etc.})</td>
<td>21</td>
<td>29</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Reducing operator fatigue during operation</td>
<td>17</td>
<td>30</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reducing exposure to chemicals during spraying</td>
<td>12</td>
<td>27</td>
<td>13</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Avoiding in-field obstacles (\text{rocks, ditches, etc.})</td>
<td>5</td>
<td>21</td>
<td>22</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note.* SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree

**Objective Three: Describe Crop School Attendees’ auto-guidance technologies training preferences.**

Participants ranked three sections of the presentation by how effective they were at helping them learn about auto-guidance. The sections ranked were PowerPoint/pictures, teaching demonstration, and hands-on portion with laptop.

Participants were asked to rate the sections as most effective, effective, and least effective. There were 29 participants who rated the hands-on portion using the laptop as the most effective. There were 30 participants who rated the teaching demonstration as effective. There were 21 participants who rated the PowerPoint/Picture portion of the presentation as least effective.

Participants were asked to indicate what sources they use to get information about auto-guidance technology. The majority \((f = 23, 74.2\%)\) of auto-guidance users indicated using dealers and consultants as information sources. From the 30 non-users of auto-guidance technology, the majority \((f = 14, 46\%)\) said that other farmers were used as sources to get information about auto-guidance technology. Users \((f = 6, 19.4\%)\) and non-
users \((f = 5, 16.7\%)\) both agreed that technical publications were the place that they sought least for information on auto-guidance technology. Few \((f = 13, 21.3\%)\) participants used information from university and Extension professionals. Users of auto-guidance reported that they sought information from the internet \((f = 15, 48.4\%)\) and other farmers \((f = 16, 51.6\%)\) of auto-guidance technology. In the other category, users wrote in conventions/trade shows \((f = 1, 1.6\%)\) and son \((f = 1, 1.6\%)\) as sources. The 30 non-users said they used internet \((f = 13, 43.3\%)\), dealer/consultants \((f = 10, 33.3\%)\), and university/Extension professionals \((f = 7, 23.3\%)\) as additional sources of information.

Participants were asked to indicate their level of agreement that hands-on training is needed for using auto-guidance with selected agricultural equipment. Participants used a 5-point Likert scale ranging from 1 = *Strongly Disagree* through 5 = *Strongly Agree* (see Table 5). When constructing a summated mean for Table 5, statistics show a mean of 4.33. This indicates that farmers are highly interested in receiving training on auto-guidance systems in the future. A total of 25 (41\%) indicated they strongly agreed that hands-on training was needed for using auto-guidance technology with tractors. Self-propelled windrowers had the second highest level of agreement that there was a need for hands-on training. There were 23 (37.7\%) participants who strongly agreed that hands-on training was needed for using auto-guidance with self-propelled windrowers. Fewer participants indicated agreement that hands-on training was needed for using auto-guidance with forage harvesters.

Table 5

*Future Training Need for Using Auto-guidance with Agricultural Equipment*
Objective Four: Identify crop school attendees’ perceived attributes leading to the adoption of technology innovations.

Rogers’ (2003) level of adoption categories serves to classify participants as innovator, early adopters, early majority, late majority, or laggards. A list of adopter categories with descriptions were provided for participants to choose from. Participants were asked to describe what category best describes them when adopting new technologies. Users of auto-guidance identified themselves as innovative ($f = 3, 9.7\%$), early adopter ($f = 7, 22.6\%$), early majority ($f = 17, 54.8\%$), and late majority ($f = 2, 6.5\%$). Non-users identified themselves as early adopter ($f = 3, 10\%$), early majority ($f = 9, 30\%$), late majority ($f = 6, 20\%$), and laggard ($f = 8, 26.7\%$).

Objective Five: Determine the association between selected variables and decision to use auto-guidance.

Chi-square test of independence was used to determine the association between use of auto-guidance and selected variables. Selected variables included education level, diffusion of innovation category, and size of farm. An independent $t$ test was used to determine if there was a significant difference in age between users and non-users.

Chi-square test of independence was used to determine the association between use of auto-guidance and level of adoption category. Adoption categories were collapsed
to examine relationships between variables using the chi-squared test of independence. This was done to reduce the number of cells with expected counts less than five. A 2 x 2 contingency table was developed. There was a significant difference, $\chi^2 (1) = 14.649$, $p = .000$, $\phi = .516$, in the proportion of “early adopters” between users and non-users of auto-guidance. The Phi coefficient indicated a moderate to strong relationship between decision to use auto-guidance and self-identified level of adoption. Users ($f = 27$, 93.1%) of auto-guidance technology more frequently self-identified themselves as an early adopter. There were only two (6.9 %) users self-identified as “late adopter.” Non-users of auto-guidance more frequently self-identified themselves as a late adopter ($f = 14$, 53.8%).

Average farm size in Utah of 608 acres was used to classify farm size reported by participants (USDA, 2014). Farm size categories were classified as either below average or above average. There was a significant association, $\chi^2 (1) = 4.726$, $p = .030$, between use of auto-guidance technology and farm size. Participants reporting using auto-guidance more often reported having more acreage at or above the Utah average farm size. The Phi coefficient indicated the strength of the relationship was moderate. There were 16 (53%) users that reported having a below average farm size and 11 (40.7%) that reported as having an above average farm size. There were 20 (87%) of the non-users that reported having a below average farm size and only three (13%) having an above average farm size (Table 7).

Table 6

*Comparison of Auto-guidance Users and Non-users on Diffusion of Innovation Category*
<table>
<thead>
<tr>
<th>Adoption Category a</th>
<th>Late Adopter</th>
<th>Early Adopter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>User (n = 29)</td>
<td>2</td>
<td>6.9</td>
</tr>
<tr>
<td>Non-user (n = 26)</td>
<td>14</td>
<td>53.8</td>
</tr>
</tbody>
</table>

\[ \chi^2 (1) = 14.649, p = .000, \phi = .516 \]

Table 7

**Comparison of Auto-guidance Users and Non-users on Farm Size**

<table>
<thead>
<tr>
<th>Farm Size Category a</th>
<th>Below Average</th>
<th>Above Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>User (n = 27)</td>
<td>16</td>
<td>53.3</td>
</tr>
<tr>
<td>Non-user (n = 23)</td>
<td>20</td>
<td>87</td>
</tr>
</tbody>
</table>

*Note.* The mean Utah farm size is 608 acres (USDA, 2014).

\[ \chi^2 (1) = 4.726, p = .030, \phi = .307 \]

There was no significant (Table 8) relationship \( \chi^2 (1) = .579, p = .447 \) between education level and use of auto-guidance. There were 22 (75.9%, \( n = 29 \)) participants who were users of auto-guidance with at least a post-secondary degree. There were 18 (66.7%) non-user participants with at least a post-secondary degree. There was no significant difference in age between users and non-users of auto-guidance, \( t (50) = .50, p = .619 \).

Table 8
### Comparison of Users and Non-Users on Education Level

<table>
<thead>
<tr>
<th>Group</th>
<th>Education Level</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Post-Secondary Education</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>User (n =29)</td>
<td>7</td>
<td>24.1</td>
<td>22</td>
<td>75.9</td>
<td></td>
</tr>
<tr>
<td>Non-user (n =27)</td>
<td>9</td>
<td>33.3</td>
<td>18</td>
<td>66.7</td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 (1) = .579, p = .447 \]
CHAPTER V
LIMITATIONS/CONCLUSIONS/RECOMMENDATIONS

The purpose of this study was to examine variables associated with northern Utah cooperative Extension crop school attendees’ decision to use auto-guidance technology and determine training preferences. Caution should be taken when attempting to generalize the results to other populations outside this study. A 62% response rate was achieved with this study. This study has identified variables that are significantly associated with the use of auto-guidance technology.

Half of the participants in this study (50.8%) indicated using auto-guidance technology in some form in their farming practices. Most attendees’ used auto-guidance technology with tractors (36.1%) and self-propelled windrowers (32.8%). The types of auto-guidance technology varied greatly between users with 14.7% of participants using Trimble EZ Steer. This could be explained by the low cost of Trimble EZ Steer. This system is an entry level and one of the less expensive auto-guidance units available for use today with an average suggested retail price of $3,495 (BMS Precision Ag, 2015). Rogers’ (2003) suggests that a low cost introductory product encourages faster adoption. Perhaps this is the case in this instance of auto-guidance technology.

Farmers’ perceptions of auto-guidance technology were positive overall. Most participants agreed ($f = 29, 52.7\%$) that auto-guidance would provide a safety advantage by increasing their ability to monitor rear-towed equipment. Several participants indicated that corn and forage production would benefit the most from using auto-guidance technology with agricultural equipment. Overall, it appears that participants
agree that auto-guidance technology is useful for improving farm equipment management. There still remain implementation barriers with only 50% of participants using the technology.

Examining the relationships between selected variables and use of auto-guidance, revealed that education level was not significant associated with the participants decision to use the technology, $\chi^2 (1) = .579, p = .447$. The average age of all participants in this study was 49.79 years old and there was no significant difference between users and non-users of auto-guidance technology. Farm size and participants’ desired to adopt new technology were significantly associated with the decision to use auto-guidance technology. This could be explained by producers with larger acreage seeing a larger return on investment from using auto-guidance technology if they are trying to reduce input costs of the farming operation. Being able to spread cost across more acres decreases the time needed to recover investment costs associated with purchasing auto-guidance technology. This reaffirms Rogers’ theory that if a person is more innovative they are more likely to adopt new technology (Rogers, 2003). It is recommended that Extension and agricultural equipment businesses consider the needs of clientele prior to engaging in marketing and educational outreach in order to maximize their efforts.

Participants’ responses indicated higher agreement for needing hands-on training using auto-guidance with tractors than other agricultural equipment. This is most likely associated with the versatility of tractors and the many tasks that require the use of a tractor. The primary tasks that make up most of the production work include tillage, planting, and harvesting. Most participants (50.8%) believed that alfalfa crop production would benefit the most using auto-guidance technology. These educational and
promotional efforts may consider presenting skeptical producers with the statistics related to the percentage of equipment and number of acres managed using auto-guidance technology. Most participants’ (59%) perceived that the hands-on portion using the laptop with the simulator was the most effective at helping them learn about auto-guidance. This supports tinkering self-efficacy and experiential learning theories that producers may benefit from hands-on experiences if they are to learn and use new technologies for production agriculture. To identify future venues for auto-guidance technologies outreach and educational, participants were asked to indicate where they commonly sought information to assist them with learning about auto-guidance technologies. Both Extension and agricultural technology sales representatives may consider using other farmers to help educate non-adopters on auto-guidance. As indicated by participants responses the internet may also serve as a source for providing information to market and educate farmers about auto-guidance technology.

This study has provided information that may benefit Extension agents and agribusiness professionals in the western United States on how to focus their education and marketing to producers regarding auto-guidance technology. Agricultural equipment businesses and Extension agents should try to help non-users to embrace new technology by using implementation statistics that included peer usage and management benefits. The reduction of labor costs and improved operation of equipment should also be highlighted in marketing efforts by using statistics that demonstrate the reduction in operator fatigue and errors. Future research should use a larger sample size and should be used to determine if these results are consistent with other populations in the intermountain west. This could be targeted at venues such as agricultural equipment
dealer open-houses or customer appreciation events. This may provide a comparison between groups that attend Extension meetings and those offered by the agribusinesses. Additional research should focus on determining the amount of operator errors that are reduced when auto-guidance is used.

Fewer participants of auto-guidance technology also identified using university and Extension professionals as a source of information on auto-guidance. However, users \((f = 15, 48.4\%)\) also reported the use the internet as a source of information of auto-guidance technology. Extension professionals may consider improving; their market share and making their programing more realized for these participants. Change agents can utilize the internet as an avenue to help educate producers about auto-guidance technology through fact sheets cost estimation tools and other publications. University Extension professionals may also team up with dealers and consultants at crop schools, field days, other Extension events and dealer sponsored events to educate producers about auto-guidance technology. Hands-on learning is highly sought after by users and non-users of auto-guidance technology, so demonstrations and hands-on experiences are highly recommended at all events.
REFERENCES


Retrieved from


Retrieved from


remotely sensed imagery for precision management in cotton production.

*Precision Agriculture, 9*, 195-208.


Appendix A.
Utah Auto-Guidance Use and Training Needs Survey
LETTER OF INFORMATION

Factors Influencing Farmers utilization of Auto Guidance Technology in Northern Utah

Introduction/Purpose Dr. Michael Pate and graduate student Thomas Bleazard in the School of Applied Sciences, Technology, and Education at Utah State University are conducting a research study to find out more about Utah Farmers training needs and perceptions related to auto-guidance technology. You have been asked to take part because you are a participant in a Utah State University Extension Crop School. There will be approximately 150 total participants in this research.

Procedures If you agree to be in this research study, you will be asked to complete a survey regarding auto-guidance technology training and your perception of using auto-guidance technology on the farm or ranch. A series of questions will be asked to gain insight on the perception of using auto-guidance on the farm or ranch. Additional questions will be asked to evaluate the training program presented at the Utah State University Extension Crop School.

Risks Participation in this research study involves minimal risk. There is a small risk of loss of confidentiality but we will take steps to reduce this risk.

Benefits This study may not have direct benefit to you but could provide an indirect benefit to other farmers in the future by developing training programs for working on the farm or ranch with auto-guidance technology.

Explanation and Offer to Answer Questions Mr. Thomas Bleazard has explained this research study to you and answered your questions. If you have other questions or research-related problems, you may reach Thomas Bleazard at (435) 797-3395 or thomas.bleazard@aggiemail.usu.edu

Voluntary nature of participation and right to withdraw without consequence Participation in research is entirely voluntary. You may refuse to participate, refuse to answer any questions or withdraw at any time without consequence or loss of benefits.

Confidentiality Research records will be kept confidential, consistent with federal and state regulations. Only the investigator and key personnel of the research team will have access to the data which will be kept in a locked file cabinet or on a password protected computer in a locked room. To protect your privacy, personal, identifiable information will be removed from study documents and replaced with a study identifier. Any identifying information will be stored separately from data. Completed surveys will be destroyed upon completion of the project and once data records have been checked for errors. Anticipated completion date is 05/31/2015. Each completed survey will be given an alphanumeric code for entering responses for data analysis.

IRB Approval Statement The Institutional Review Board for the protection of human participants at Utah State University has approved this research study. If you have any questions or concerns about your rights or a research-related injury and would like to contact someone other than the research team,
LETTER OF INFORMATION

Factors Influencing Farmers utilization of Auto Guidance Technology in Northern Utah

you may contact the IRB Administrator at (435) 797-0567 or email irb@usu.edu to obtain information or to offer input.

Investigator Statement “I certify that the research study has been explained to the individual, by me or my research staff, and that the individual understands the nature and purpose, the possible risks and benefits associated with taking part in this research study. Any questions that have been raised have been answered.”

Signature of Researcher(s)

Michael L. Pate, Ph.D.
Principal Investigator
Assistant Professor
(435-797-3508)
Michael.pate@usu.edu

Thomas Bleazard
Student Researcher
(435-797-3395)
Thomas.bleazard@aggiemail.usu.edu
Utah Auto-guidance Technology Use and Training Needs
Survey

The purpose of the study is to assess factors that impact farmers’ adoption of auto-guidance technology in alfalfa and corn silage production and identify training preferences. For this survey, auto-guidance technology is defined as electronic controls and monitors in combination with GPS software that is used to control the travel and direction of agricultural vehicles.

Precision agricultural technology graphic by www.caseih.com

Please answer honestly and openly. This survey should only take 5 minutes to complete. There are 16 questions. The information you provide will be kept confidential and will help assist in educational programming efforts to assist with the safe and efficient use of auto-guidance technology in agriculture.

Instructions: For each question, please place an "X" in the box next to your answer choice(s). Please continue on the next page.
1. Which vehicle steering system do you use for auto guidance? Check all that apply.
- Trimbale® EZ-Steer™
- Trimbale® EZ-Pilot™
- Trimbale® Autopilot™
- Ag Leader® ONTRAC3™
- Ag Leader® PARADYME®
- Ag Leader® GeoSteer®
- Case IH AFS Accuguide™
- New Holland Intellisteer™
- John Deere Auto Trac™
- Other: __________________________
- I don’t use auto-guidance

2. In which equipment do you use auto guidance? Check all that apply.
- Tractors
- Forage Harvester
- Self-propelled Windrowers
- Combine
- Sprayer
- Other: __________________________
- Not applicable

3. Do you plan to implement auto guidance in your farming activities? Please check one.
- Never
- In the distant future (more than two years)
- In the near future (less than two years)
- Already implementing but no plans to increase usage
- Already implementing with plans to increase usage

4. Which type of crop production operation do you perceive would benefit the most from using auto-guidance? Check only one.
- Alfalfa
- Corn
- Wheat
- Beans
- Other: __________________________

5. Please select the statement that best describe you and your beliefs on adopting technology. Check only one.
- I want to be the first to try an innovation. I am very willing to take risks.
- I enjoy and embrace change opportunities I am very comfortable adopting new ideas.
- I adopt new ideas before the average person, but typically need to see evidence that the innovation works.
- I am skeptical of change, and will only adopt an innovation after it has been tried by other people I respect.
- I am considered very conservative. I am very skeptical of new technology.

6. Please rank the following training session activities from 1 to 3 based on how effective they were at helping you learn about auto-guidance systems. 1 = Most effective, 2= Effective and 3 = Least effective.

- PowerPoint/Pictures
- Teaching demonstration
- Hands-on portion with laptop

7. What sources of information do you use to get information about auto guidance technologies? Check all that apply.
- Internet
- Other Farmers
- Dealers/Consultants
- Agriculture and Technical Publications
- University/Extension Professionals
- Other: __________________________

Please continue on the next page.
For questions 8 through 10, please answer using one of the five responses ranging from strongly agree (SA), agree (A), neutral (N), disagree (D) and strongly disagree (SD).

8. Please indicate your agreement that auto-guidance would be useful for:

<table>
<thead>
<tr>
<th>Topic</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing yield per acre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing the ability to farm more acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducing input cost (fuel, fertilizer, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting data for future management decisions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing machine capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Please indicate your agreement that auto-guidance is beneficial to safety by:

<table>
<thead>
<tr>
<th>Topic</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoiding in field obstacles (rocks, ditches, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducing operator fatigue during operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducing exposure to chemicals during spraying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing operators’ ability to monitor towed equipment (baler, plow, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. Please indicate your agreement that hands-on training is needed for using auto-guidance with:

<table>
<thead>
<tr>
<th>Topic</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forage harvesters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-propelled Windrowers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other: ___________________________</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. What is your gender?

☐ Male  ☐ Female  ☐ Prefer not to respond

12. What is your age in years?

_____________

13. What is the highest level of education that you have received? Check only one.

☐ High School/GED  ☐ 4-yr Bachelor’s Degree
☐ Technical Certificate  ☐ Graduate Degree
☐ Associates Degree  ☐ Other: ________________

Please continue on the next page.
14. What makes up the majority (> 50% of your total cash receipts) of your farm production?  
Check only one.  
☐ Dairy  
☐ Forage (Alfalfa)  
☐ Beef Cattle  
☐ Corn Silage  
☐ Swine  
☐ Grain (corn, wheat, etc.)  
☐ Poultry  
☐ Fruit  
☐ Vegetables  
☐ Other: ____________________

15. Please estimate the number of acres you operate for crop production.  
________________________ total acres

16. How many of those acres are irrigated?  
________________________ irrigated acres

Thank you for participating in this survey concerning the adoption of auto-guidance and the training preferences for Utah farmers. I very much appreciate your time you have spent filling out the survey and providing essential information needed to complete my thesis. The information that you have provided me will help me make conclusions and provide information to extension regarding auto-guidance technology training needs.

Thank you,

Thomas Bleazard
Appendix B.

Auto-Guidance in Agriculture
## Lesson Plan

<table>
<thead>
<tr>
<th>Instructional Plan</th>
<th>Instructor: Thomas Bleazard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lesson Title:</strong> Auto-guidance in Agriculture</td>
<td></td>
</tr>
<tr>
<td><strong>Estimated Time:</strong> 25 min</td>
<td></td>
</tr>
</tbody>
</table>

### Objective: (Overall objective for the class)
Help learners to understand auto-guidance technology and test the impact that curriculum has on learners.

### Materials, Supplies, Equipment, References, and Other Resources:
- [ ] Computer
- [ ] Projector
- [ ] Classroom
- [ ] Classroom Guidance Equipment (monitors, receivers, cords, hand held GPS, RTK base station) (Royce)
- [ ] Simulator software
- [ ] Laptops for hands on portion
- [ ] Cart with guidance system

### Situation: (who are you teaching to)
Farmer in northern Utah that have no knowledge to a working knowledge of auto-guidance technology in agriculture.

### Interest Approach (Motivation):
What is the current level of adoption of auto-guidance technology and what is affecting adoption?

### Communicate Objectives, Define Problem or Decision to be Made, or Identify Questions to Investigate:
Auto-guidance Basics. What is auto-guidance and why do we need it? What are systems are used for.

<table>
<thead>
<tr>
<th>Instructor Directions / Materials</th>
<th>Content Outline, Instructional Procedures, and/or Key Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>• Thomas Bleazard graduate student at USU in Agriculture Systems Technology Department</td>
</tr>
<tr>
<td></td>
<td>• Master’s thesis focus is on auto-guidance systems in agriculture applications</td>
</tr>
<tr>
<td></td>
<td>• Here to give you information about auto-guidance systems for use in agriculture and ask you a few questions about you use of this technology</td>
</tr>
<tr>
<td>Instructor Directions / Materials</td>
<td>Content Outline, Instructional Procedures, and/or Key Questions</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Power point</td>
<td>(one slide and one minute)</td>
</tr>
<tr>
<td></td>
<td>• What is auto-guidance?</td>
</tr>
<tr>
<td></td>
<td>• Components on your tractor (monitor, GPS receiver, antenna</td>
</tr>
<tr>
<td></td>
<td>steering controls, sensors etc.)</td>
</tr>
<tr>
<td></td>
<td>• Global network of satellites (24 or more)</td>
</tr>
<tr>
<td></td>
<td>• Correction satellites (differential correction satellites)</td>
</tr>
<tr>
<td></td>
<td>• Base station</td>
</tr>
<tr>
<td></td>
<td>• Cell towers</td>
</tr>
<tr>
<td></td>
<td>• Radio</td>
</tr>
<tr>
<td></td>
<td>(Two slides about three minutes)</td>
</tr>
</tbody>
</table>

- Chart comparison

- Systems overview
- Four major types of systems
- Priced low, medium, and high
- Facts about each system (accuracy, uses and benefits)
  (One slide about three minutes)

<table>
<thead>
<tr>
<th>Application:</th>
<th>Simulation Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop Computers</td>
<td>- What questions do you have before we look at a guidance</td>
</tr>
<tr>
<td>Trimble CFX 750 simulator</td>
<td>simulator?</td>
</tr>
<tr>
<td></td>
<td>- Answer or say good we can look at the simulation and answer</td>
</tr>
<tr>
<td></td>
<td>that one</td>
</tr>
<tr>
<td></td>
<td>(one minute)</td>
</tr>
</tbody>
</table>

- Here is an actual unit that you will be simulating on the computer today
  - This is a Trimble CFX 750.
  - It is a mid range unit.
  - These are not brand specific to John Deere, Case, New Holland, etc…
  - Other systems like StarFire, Ag Leader, Trimble etc… are similar in size and function.
  - I chose this unit because of its functions, accuracy range, cost and the ability to use it in any tractor.
  (one minute)

- CFX 750 Set Up (have everyone move to the laptop computers. Students will enter on laptop computer and adjust the settings while instructor is guiding them through the process)
<table>
<thead>
<tr>
<th>Instructor Directions / Materials</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- I previously connected the CFX 750 with a EZ-Steer steering system for the automatic guidance.</td>
</tr>
<tr>
<td></td>
<td>- Was set up for a row crop tractor. Tractor wheel base antenna height and so on was set for a specific tractor.</td>
</tr>
<tr>
<td></td>
<td>- Everyone please go to the top of the page and select simulator and then start from the pull down menu.</td>
</tr>
<tr>
<td></td>
<td>- Then on the Easy-Steer start warning page pull the slider bar down and hit the green check mark.</td>
</tr>
<tr>
<td></td>
<td>- This brings you to the main operation page. This is what you will see when you are operating your tractor.</td>
</tr>
<tr>
<td></td>
<td>(one minute)</td>
</tr>
<tr>
<td>Operation Screen</td>
<td>- Along top you will see GPS signal strength, off line in inches, MPH, data connectivity.</td>
</tr>
<tr>
<td></td>
<td>- Status and view buttons to the Left.</td>
</tr>
<tr>
<td></td>
<td>- A-B points and other quick field buttons to the right.</td>
</tr>
<tr>
<td></td>
<td>- Center red arrow is position of tractor.</td>
</tr>
<tr>
<td></td>
<td>- Left bottom button is used to mark area when using manual steering.</td>
</tr>
<tr>
<td></td>
<td>- Right bottom button engages the auto-steering.</td>
</tr>
<tr>
<td></td>
<td>(one to two minutes)</td>
</tr>
<tr>
<td>Set up implement for planting</td>
<td>(students will enter on laptop computer and adjust the settings while instructor is guiding them through the process)</td>
</tr>
<tr>
<td></td>
<td>- Implement measured 20”.</td>
</tr>
<tr>
<td></td>
<td>- 3 pt hitch implement.</td>
</tr>
<tr>
<td></td>
<td>- Forward back offset.</td>
</tr>
<tr>
<td></td>
<td>- Overlap or skip.</td>
</tr>
<tr>
<td></td>
<td>(three minute)</td>
</tr>
<tr>
<td>Set Pattern Type</td>
<td>- A-B, A+, Identical curve etc.</td>
</tr>
<tr>
<td></td>
<td>- If help is needed in the field then Go into help at top of screen to get definitions. (Click on the question mark icon)</td>
</tr>
<tr>
<td></td>
<td>(one minute)</td>
</tr>
<tr>
<td>Instructor Directions / Materials</td>
<td>Content Outline, Instructional Procedures, and/or Key Questions</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Record a Boundary?               | Boundary is a path around the field that the GPS system uses to mark an edge or stopping point.  
                                   | Computer will automatically shutdown sprayer or other connected implements when boundary is reached. (thirty seconds to one minute) |
| Confirm the Configuration        | Add name field and other information.  
                                   | This is a record keeping stage. You can use this setup later by selecting it from a list so reprogramming does not have to occur. (one minute) |
| Record keeping                   | What was done (spray, plant, harvest)  
                                   | Weather information  
                                   | Operator and license info. You can use this setup later by selecting it from a list so reprogramming does not have to occur. (one minute) |
| Engage auto steering             | Must be going the minimum speed of 1.2 mph to engage auto steering click the faster arrow at bottom of the computer screen.  
                                   | Must have an A-B line set to engage steering  
                                   | Set A-B line by speeding up simulator and selecting Map A Point, on the top right of the screen  
                                   | When the tractor has moved far enough Map B point will light up in color. Select Map B Point when you are pointed in the desired direction.  
                                   | The auto pilot bottom right corner of the screen will change from red to yellow in color. It is in the shape of a steering wheel. Hit the auto pilot button and the auto steer system will take control of the steering  
<pre><code>                               | Light bar at top of the screen will tell you how far off line the tractor is. |
</code></pre>
<table>
<thead>
<tr>
<th>Instructor Directions / Materials</th>
<th>Content Outline, Instructional Procedures, and/or Key Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn around</td>
<td>(one to two minutes)</td>
</tr>
</tbody>
</table>

- Turn your tractor around by slowing your speed down to 2.2 mph or so.
- Turning the steering wheel at the bottom of the computer screen to the right or left.
- Notice as you turn new A-B lines automatically appear
- After turning around when you are close to the A-B line engage button will be orange. (if red you cannot engage)
- Yellow track behind the red arrow will show gaps or overlaps in the field during the activity.
- Can skip multiple rows and comeback later (faster turnaround time)
- End of simulator
  (one to two minutes)

- Questions?
- Contact information for Thomas Bleazard for further questions that can’t be answered at class.

2 minutes

Paper Based Survey

- survey

5 minutes