Using Simulation in Auto-Guidance Technology Training among Farmers in Utah

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Abstract

The purpose of this descriptive-correlation study was to examine the variables associated with Utah farmers’ adoption of auto-guidance technologies 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 in production agriculture settings. A survey was administered to identify auto-guidance technology adoption and farmers’ preferences for related training. A total of 61 participants completed the survey from two different Cooperative Extension Crop Schools in Utah. Half of the participants in this study (50.8%) indicated using auto-guidance technology in some form in their farming practices. Participants ranked three sections of the presentation by how effective they were at helping them learn about auto-guidance. Hands-on training on auto-guidance technology reported as the most effective training presentation component by the participants.

Keywords: auto-guidance, training preferences, hands-on training, farming, adoption
**Introduction/Background**

Even with the documented advantages of using auto-guidance technologies on the farm, the adoption level of auto-guidance technologies has been shown to vary depending on several factors (Daberkow & McBride, 2003). Kitchen, Snyder, Franzen, and Wiebold (2002) noted that there was a lack of confidence in precision agriculture. 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). Diekmann and Batte (2010) reported that two-thirds of 1,163 farmers strongly agreed that there is lack of educational training in precision agriculture of which auto-guidance is a part. 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. Kitchen et al. (2002) recommended that farmers have hands-on experience when learning to use precision agriculture products. 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. The main factors affecting the adoption of precision agriculture were stated as farm size, computer literacy, full-time farming occupation, farm type and location, job satisfaction, management “know-how”, and success in crop production (Busse et al., 2014; Paustian & Theuvsen, 2017).

Developing and conducting effective training programs for auto-guidance technologies present unique challenges. Operation of agricultural machinery can be a hazardous task for the operator. Farmers can gain confidence as they experience auto-guidance technologies through simulations, helping them overcome barriers to entry that are too great to overcome on their own. Simulation is a technique for practice and learning that can be applied to different disciplines and trainees such as engineering, health professions, driving, and mining (Lateef, 2010). Yan, Abdel-Aty, Radwan, Wang, and Chilakapati (2008) concluded that a driving simulator can be utilized as a valid tool to assess traffic safety. Researchers also used simulators to increase the understanding of the tilt angles for tractor and ATV stability (Gorucu, Cavallo, & Murphy, 2014; Cavallo, Gorucu, & Murphy, 2015). Using a simulator has many advantages including experimental control, efficiency, expense, safety, and ease of data collection (Nilsson, 1993). When trialing a practice becomes less costly, it is more likely to be seen as worthwhile; thus, increasing the adoption of the technology (Pannell, Marshall, Barr, Curtis, Vanclay, & Wilkinson, 2006).

While there have been many studies completed that have surveyed farmers about adoption of auto-guidance technologies, few studies have documented training preferences for learning about these technologies (Diekmann & Batte, 2010; Jenkins, 2009; Kitchen et al., 2002; Lavergne, 2004; Winstead et al., 2010). Research is needed to identify effective approaches for teaching how to use auto-guidance technology in agricultural settings.

**Conceptual Framework**

The conceptual framework for this study was constructed from the tenets of diffusion of innovation theory and experiential learning theory.
Diffusion of Innovation
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.” 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 concept of trialability can be integrated with experiential learning theory as a form of experimentation.

Experiential Learning Theory
Experimentation with new ideas and concepts plays a central role in making the learning process more meaningful for the individual (Kolb, 1984). Experiential learning as explained by Kolb (1984) is a learning process by which doing creates knowledge. Providing a hands-on simulation activity may allow users a trial opportunity with auto-guidance and therefore increase their knowledge of auto-guidance technology. This idea suggests that producers may prefer learning about auto-guidance technology through hands-on experiences rather than informational sessions typically seen at farm trade shows.

Purpose and Objectives
The purpose of this study was to examine the variables associated with Utah Cooperative Extension Crop School attendees’ decisions to use auto-guidance technology in alfalfa and corn silage production and determine training preferences. The study was guided by the following objectives.

1) Describe and identify the current use of auto-guidance systems among Cooperative Extension Crop School attendees in Utah.
2) Identify Crop School Attendees’ perceptions of auto-guidance systems.
3) Describe Crop School Attendees’ auto-guidance technologies training preferences.

Methods

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 paper-based survey to provide questions to the population.

Participants
The target population for this study was Utah State University Cooperative Extension crop school attendees over the age of 18 who primarily engage in alfalfa and corn silage production in Utah. Approximately 99 individuals attended the crop schools hosted by Utah State University Extension at two different locations (Cache County Crop School and consolidated Weber/Davis/Morgan County Crop School) 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 Utah State University Agricultural System Technology students who were currently taking a course in a related field. Survey questions were examined and modified to

increase the instrument’s reliability and validity based on expert suggestions and the pilot test (Sallee, Edgar, & Johnson, 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 0.75 and 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 section had an intra-class correlation coefficient of 0.91.

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 (α = 0.91). Participants were also asked about their perceived auto-guidance technology training needs (α = 0.89).

Training Program
The training presentation components consisted of a PowerPoint presentation, teaching demonstration, and hands-on instruction. 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 function, advantages and disadvantages, cost, and uses for each type of system. The presentation objective was 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.

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
Descriptive statistics including frequencies, percentages, mean and standard deviation were used to report results of the survey. A chi-square test was used to determine the association between decision to use auto-guidance and selected variables. Selected variables were education level, diffusion of innovation category, and size of farm.

Results/Findings

Objective One: Describe and identify the current use and perceptions of auto-guidance systems among Cooperative Extension Crop School attendees in Utah.
A total of 99 participants attended both crop schools and 61 of them completed the survey. The completed and returned surveys were from Cache County Crop School (f = 11) and consolidated Weber/Davis/Morgan County Crop School Crop School (f = 50). The majority of participants reported being male (f = 56, 91.8%), there was one female participant and four participants did not self-report their gender. The average reported age of participants was 49 (SD = 14.16).

Individuals were classified as users (f = 31, 50.8%) if they indicated using auto-guidance with agricultural equipment. If participants indicated that they did not use auto-guidance, they were classified as non-users (f = 30, 49.2%). The mean acres operated for crop production were 2572 acres for auto-guidance users and 325 acres for non-users. Auto-guidance users indicated that they are using auto-guidance technology with tractors (f = 22, 71%), sprayers (f = 20, 65%), windrowers (f = 8, 26%), combines (f = 5, 16%), and others (f = 6, 19%).

Objective Two: Identify Crop School Attendees’ perceptions of auto-guidance systems.
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). Table 1 shows the percentages for each management goal by user status. The summated mean for Table 1 was 4.18 (SD = 0.51) indicating that participants had a positive attitude towards auto-guidance technologies usefulness. Among responses, the largest portion of all participants (52.7%) strongly agreed that auto-guidance would be useful for reducing input cost such as fertilizer and fuel cost. A large proportion of all respondents agreed that auto-guidance would be useful for increasing their yield per acre (50.9%), increasing their ability to farm more acres (60.4%), collecting data for future management decisions (47.3%), and increase machine capacity (45.3%) (Table 1).

When compared to users of auto-guidance who agreed to strongly agreed (f = 25, 86.2%), fewer non-user respondents (f = 17, 65.4%) agreed to strongly agreed that auto-guidance would be useful to increase yield per acre. This was consistent across constructs for non-user respondents (see table 1). Chi-Square Test of Association was used to determine if there was a significant association in respondents’ perceived usefulness of auto-guidance based. There was
Table 1. Auto-guidance Usefulness with Assisting in Accomplishing Selected Farm Management Goals

<table>
<thead>
<tr>
<th>Topic</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing input cost (fuel, fertilizer, etc.)</td>
<td>62.1%</td>
<td>42.3%</td>
<td>34.5%</td>
<td>46.2%</td>
<td>3.4%</td>
</tr>
<tr>
<td>(n = 55)</td>
<td>(f = 18)</td>
<td>(f = 11)</td>
<td>(f = 10)</td>
<td>(f = 12)</td>
<td>(f = 1)</td>
</tr>
<tr>
<td>Collecting data for future management decisions</td>
<td>48.3%</td>
<td>34.6%</td>
<td>41.4%</td>
<td>53.8%</td>
<td>6.9%</td>
</tr>
<tr>
<td>(n = 55)</td>
<td>(f = 14)</td>
<td>(f = 9)</td>
<td>(f = 12)</td>
<td>(f = 14)</td>
<td>(f = 2)</td>
</tr>
<tr>
<td>Increasing machine capacity</td>
<td>34.0%</td>
<td>34.0%</td>
<td>45.3%</td>
<td>34.0%</td>
<td>20.8%</td>
</tr>
<tr>
<td>(n = 53)</td>
<td>(f = 18)</td>
<td>(f = 18)</td>
<td>(f = 24)</td>
<td>(f = 18)</td>
<td>(f = 11)</td>
</tr>
<tr>
<td>Increase the ability to farm more acres</td>
<td>32.1%</td>
<td>20.0%</td>
<td>64.3%</td>
<td>56.0%</td>
<td>3.6%</td>
</tr>
<tr>
<td>(n = 53)</td>
<td>(f = 9)</td>
<td>(f = 5)</td>
<td>(f = 18)</td>
<td>(f = 14)</td>
<td>(f = 1)</td>
</tr>
<tr>
<td>Increasing yield per acre</td>
<td>34.5%</td>
<td>15.4%</td>
<td>51.7%</td>
<td>50.0%</td>
<td>6.9%</td>
</tr>
<tr>
<td>(n = 55)</td>
<td>(f = 10)</td>
<td>(f = 4)</td>
<td>(f = 15)</td>
<td>(f = 13)</td>
<td>(f = 2)</td>
</tr>
</tbody>
</table>

Note: For each construct, a total of 26 non-users and 29 users responded.
no significant difference in perceived attitude towards auto-guidance technologies usefulness with assisting in accomplishing selected farm management goals between auto-guidance users and non-users ($p > 0.05$).

**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 (59.2%) who rated the hands-on portion using the laptop as the most effective. There were 11 participants (22.0%) who rated the teaching demonstration as most effective. There were 21 participants (42.9%) who rated the PowerPoint/Picture portion of the presentation as least effective. The auto-guidance users and non-users did not differ in terms of their self-reported effectiveness level of both power point presentation and teaching demonstration ($p > 0.05$). However, there was a significant difference between auto-guidance users and non-users on the effectiveness level of hands-on training ($\chi^2 (2) = 8.576, p = 0.014$): 76% of the non-users reported that hands-on training would be most effective as compared to 46% of the auto-guidance users.

Participants were asked to indicate the sources they use to get information about auto-guidance technology. The major information source reported by auto-guidance users were dealers (74%), followed by other farmers (52%), internet (48%), agricultural and technical papers (19%), university/extension professionals (19%), and others (7%). From the 30 non-users of auto-guidance technology, the largest proportion of non-user respondents (47%) said that ‘other farmers’ were used as sources to get information about auto-guidance technology, followed by internet (43%), dealers (33%), university/extension professionals (23%), agricultural and technical papers (17%), and others (7%).

Participants were asked to indicate their level of agreement that hands-on training was 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). The summated mean for Table 2 was 4.33 ($SD = 0.67$). This indicates that farmers are highly interested in receiving hands-on training on auto-guidance systems in the future. A total of 25 (46.3%) 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, with 23 (46.9%) participants in strong agreement. Fewer participants indicated agreement that hands-on training was needed for using auto-guidance with forage harvesters.

Table 2. Future Hands-on Training Need for Using Auto-guidance with Agricultural Equipment

<table>
<thead>
<tr>
<th>Topic</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractors ($n= 54$)</td>
<td>46.3%</td>
<td>44.4%</td>
<td>9.3%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>($f = 25$)</td>
<td>($f = 24$)</td>
<td>($f = 5$)</td>
<td>($f = 0$)</td>
<td>($f = 0$)</td>
</tr>
<tr>
<td>Self-propelled Windrowers ($n= 49$)</td>
<td>46.9%</td>
<td>36.7%</td>
<td>16.3%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>($f = 23$)</td>
<td>($f = 18$)</td>
<td>($f = 8$)</td>
<td>($f = 0$)</td>
<td>($f = 0$)</td>
</tr>
<tr>
<td>Forage Harvesters ($n= 46$)</td>
<td>41.3%</td>
<td>39.1%</td>
<td>19.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>($f = 19$)</td>
<td>($f = 18$)</td>
<td>($f = 9$)</td>
<td>($f = 0$)</td>
<td>($f = 0$)</td>
</tr>
</tbody>
</table>

Conclusion

The purpose of this study was to examine variables associated with Utah cooperative Extension crop school attendees’ decision to use auto-guidance technology and determine training preferences. A 62% response rate was achieved with this study. Half of the participants in this study (50.8%) indicated using auto-guidance technology in some form in their farming practices. Most auto-guidance users used auto-guidance technology with tractors (71%) and sprayers (65%).

Overall, the participants agreed that auto-guidance would reduce the input cost, help increase their yield per acre, increase their ability to farm more acres and collect data for future management decisions, and increase machine capacity.

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. 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. It should be noted that 76% of the non-users reported that hands-on training would be most effective as compared to 46% of auto-guidance users. The difference between users and non-users was statistically significant. The results of this study indicated support that producers may benefit from hands-on experiences when considering adoption of 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. Responses from this study suggest that 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.

References


