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Enhancing Extension Programs by Discussing Water Conservation Technology Adoption with Growers

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Abstract

Nursery growers are one of the largest agricultural users of water. Researchers have been developing new water treatment techniques and technologies for nursery growers to assist in preserving this precious resource, yet adoption within the industry has been limited. Extension professionals need to work closely with nursery growers to encourage adoption but the enablers and barriers are largely unidentified in the literature. Twenty-four interviews were conducted with nursery growers nationwide to identify the barriers and enablers to adoption in an effort to provide recommendations for improved extension programming with this audience. The findings revealed nursery growers have a positive attitude towards water conservation but the financial cost of replacing equipment keeps them from adopting. In addition, nursery growers perceive new technologies to be complex and difficult to understand and implement. Extension professionals can leverage this positive attitude and use social norms to assist in overcoming some of the barriers. Using case studies as examples of success stories, partnering with researchers to develop easy to use instructions and integration tools that could be offered online, and assisting growers in connecting with agricultural economists to conduct cost/benefit analysis associated with adoption are a few of the recommendations offered.

Keywords: nursery growers, water conservation, water treatment, extension, technology adoption

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Introduction

Water issues are a major threat to the future of the nursery and greenhouse industry (Kratsch, Ward, Shao, & Rupp, 2010) with the management of water resources among growers described "as a national (or even international) challenge requiring local solutions" (Mezitt, 1992, p. 82). The ground and surface water used to grow plants can impact water availability and fertilizers, and horticultural chemicals can affect water quality through leaching and runoff (Yeager, Million, Larsen, & Stamps, 2010). Growers have also been found overwatering their plants, preferring the risk of overwatering to the risks of underwatering (Yeager et al., 2010). In addition, a large percentage of growers (55%) rely on overhead irrigation which has been found to

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be less efficient than new technologies and techniques and the number of growers drawing on city water supplies is increasing (Hodges, Khachatryan, Hall, & Palma, 2015).

Through their connection to the land and to natural resources, growers are "positioned in a uniquely environmentally oriented sector of our economy" (Mezitt, 1992, p. 82) with a great opportunity to protect water resources. More than two billion dollars were invested in improving existing and installing new irrigation systems between 2003 and 2008 among agricultural producers (Schaible & Aillery, 2012), yet there is still more that can be done. Growers can use more precise irrigation technologies to supply water in smaller amounts throughout the day or treat and reuse water onsite (Hodges et al., 2015; Yeager et al., 2010). Growers can also protect water quality by storing rainwater to reduce runoff, containing and treating irrigation water and using it more than once, and using technologies to ensure chemicals and sediments do not leave the operation.

Despite the availability of numerous research-based technologies and practices that have been developed to help growers reduce their impact on water resources, there is inconsistent adoption of these strategies (Yeager et al., 2010). In a recent survey, only 12% of the growers surveyed indicated future plans to adopt water conservation practices (Dennis et al., 2010). One challenge to encouraging sustainable practices is that growers' operations "differ so radically from traditional agronomic-type operations in terms of water and nutrient use" (Lea-Cox et al., 2010, p. 516). Educational initiatives have been proposed to encourage environmental sustainability, and extension professionals are well-positioned to help growers reduce their impact on water (Lubell, Niles, & Hoffman, 2014). Extension professionals and academic researchers provide great value to nursery and greenhouse growers because they have established credibility, powerful communication networks, and non-biased approaches to problem-solving (Lubell et al., 2014; Mezitt, 1992).

While there are many extension professionals and researchers working on water issues, much of the available research focuses on developing and improving specific technologies and practices without taking into account the powerful social and psychological elements that guide adoption (Breukers, van Asseldonk, Bremmer, & Beekman, 2012). The importance of exploring these elements was illustrated in Staats, Jansen, and Thøgersen's (2011) study which found Dutch greenhouse growers' self-efficacy and normative beliefs were correlated with intention to reduce pesticide use in their operations. To the same effect, Yeager et al. (2010) explained that decision-making surrounding irrigation is largely based on personal experience and observation. Growers may resist adopting sustainable technologies and practices for numerous reasons, yet positive attitudes, low perceived level of risk to the operation, and perceived ease of adoption has been found to influence adoption (Dennis et al., 2010). Despite the research already conducted, much is left unknown about how extension professionals can be most effective in encouraging adoption among this important audience, especially in the United States where they are one of the largest agricultural users of water. The American Association for Agricultural Education National Research Agenda: 2016-2020 emphasizes the importance of developing educational programs most applicable and effective with targeted audiences (Roberts, Harder, & Brashears, 2016), therefore a study designed to explore and document characteristics of nursery and greenhouse growers, and the relationship between these characteristics and their stewardship of water resources, is an important step in developing extension programs that can assist them in adopting water saving technologies.

Theoretical Framework

The Theory of Planned Behavior (TPB; Ajzen, 1991) was used as the theoretical framework for this study. TPB explains that intention to perform a behavior can be predicted by attitude toward the behavior, subjective norm, and perceived behavioral control (Ajzen, 1991). Attitude toward the behavior refers to how an individual perceives the behavior. If a behavior is perceived as favorable, intention to perform the behavior will increase (Ajzen, 1991). Subjective norm refers to the social approval that leads to intention to perform a behavior. TPB utilizes subjective norms to measure how individuals' perception of people who are important to them influences engagement in a behavior (Ajzen, 1991). Perceived behavioral control refers to the perceived simplicity or difficulty of adopting a behavior. When behaviors are perceived as difficult, intention to adopt the behavior and engagement in the behavior itself are expected to decrease (Ajzen, 1991).

TPB (Ajzen, 1991) has been applied to the stewardship of natural resources and agricultural/extension education in a variety of contexts (Lamm, Lamm, & Strickland, 2013; Myers & Washburn, 2008; Warner, Rumble, Martin, Lamm, & Cantrell, 2015). Beedell and Rehman (1999) sought to better understand farmers' conservation behaviors and found the individual attitude, subjective norm, and perceived behavioral control constructs were effective in providing insight into farmer's conservation behaviors. The study also suggested that farmers' beliefs about conservation prevented or encouraged conservation practices.

Lam (1999) conducted a study that measured 244 government employees' intention to conserve water. This study concluded that constructs of TPB could be used to enhance researchers' ability to capture individuals' intention to save water. Regression analysis revealed that attitude was a significant predictor for intention to conserve water but did not necessarily result in the adoption of water conservation practices or technologies. Salient factors, such as economic barriers and technological difficulty, ultimately defered implementation and adoption of the new behaviors (Guagnano, Stern, & Dietz, 1995; Lam, 1999). Positive attitudes have been directly correlated with farmers' intention to adopt sustainable land management strategies (Rossi Borges, Oude Lansink, Ribeiro, & Lutke, 2014).

Social influence, or the subjective norm, has also been a proven predictor of whether or not a group or individual will adopt a conservation behavior. For example, Lam (1999) reported that normative beliefs were an important predictor of government employees' intent to conserve water in a study in Taiwan. Blaine, Clayton, Robbins and Grewal (2012) reported that residents' perception of how their neighbor takes care of their landscape is "one of the best predictors" (p. 266) of how they personally manage their own. In a study of people who use irrigation in the home landscape, Warner et al. (2015) found that subjective norms were a significant predictor of residents' intent to engage in water conservation practices. Similarly, Trumbo and O'Keefe (2001) used TPB to explain intent to conserve water among residents in three communities who shared a watershed, and Oskamp et al. (1991) found that whether a person's friends and neighbors recycled was an important factor in whether they recycled. The authors concluded that social influence could be used effectively as a behavior change tool.

Perceived ease or difficulty of use, referred to as perceived behavioral control, has also been associated with intention to adopt natural resource conservation practices. In a study examining strawberry growers' decisions to adopt conservation technologies, Lynne, Franklin Casey, Hodges, and Rahmani (1995) found perceived behavioral control was often the deciding factor in the adoption or nonadoption of conservation technologies. Participants were given a description of drip irrigation technology and asked how much control they have in implementing this type of system. Results revealed many growers did not believe they had complete control, due to a lack of capital associated with installation. Growers have been known to focus on lesser goals in areas where their self-efficacy is low (Staats et al., 2011). For example, Breukers et al. (2012)

found positive relationships between perceived behavioral control and attitude towards managing invasive plant pathogens.

Purpose and Research Questions

The purpose of this study was to develop an understanding of how the three TPB factors impacted nursery and greenhouse growers' intention to adopt water conservation and treatment technologies to inform the development of extension education programs and communication campaigns designed to encourage adoption. The study was guided by the following research questions:

1) How does attitude influence intent to adopt water conservation practices and treatment technologies?
2) How does perceived behavioral control influence intent to adopt water conservation practices and treatment technologies?
3) How do subjective norms influence intent to adopt water conservation practices and treatment technologies?

Methods

In-depth interviews were chosen as the data collection method to address the research questions due to the limited amount of literature on the sociological elements that come into play when growers consider water conservation and treatment technologies. The researchers selected semi-structured interviews so they could engage in conversation with participants while strategically staying on task with the interview guide. The approach also allowed participants to answer questions as candidly as possible (DiCicco-Bloom & Crabtree, 2006).

Instrument Development

An interview guide was created by two researchers whose areas of specialization included extension education and social science research and was then reviewed by a team of researchers focused on developing water treatment technologies and water conservation practices. The interview guide was developed to explore the TPB factors believed to contribute to nursery and greenhouse water management decisions. The format included questions and probes that encouraged growers to share in-depth information about their operation's water conservation and treatment activities, describe their feelings toward water saving and treatment technologies, and explain the benefits they associate with treating and re-using water.

Data Collection

Data were collected through semi-structured interviews. Semi-structured interviews allow researchers to ask questions that are not on the interview guide during the course of the interview but ensures the germane research questions are asked at all interviews (Bryman, 2003). To ensure quality of data, the interviews were designed to be one-on-one and in-depth for a more personal experience between the interviewer and interviewee, allowing the researchers to build rapport with the interviewee. In qualitative research, building rapport is essential to "establishing a safe and comfortable environment for sharing the interviewee's personal experiences and attitudes as they actually occurred" (DiCicco-Bloom & Crabtree, 2006, p. 316).

Twenty-four interviews were held onsite at nursery and greenhouse operations geographically dispersed around the U.S. Study participants were selected to represent diversity in operation size, geographic location, and production methods. Study participants included growers at crop production operations participating in the United States Department of Agriculture (USDA) sponsored study: Clean WateR[3] – Reduce, Remediate, Recycle – Enhancing Alternative Water Resources Availability and Use to Increase Profitability in Specialty Crops. Operations ranged in size from small family-owned operations to large chain operations. Most operations practiced water recycling in some form. The research was qualitative in nature and focused on growers interested in learning more about water treatments and technologies and therefore a limitation of the study is that the results should not be generalized to the larger population.

Subjectivity Statement

The researcher who conducted the interviews and analyzed the data was a trained public health professional with a professional focus in social and behavioral science research. The researcher had previously conducted interviews in the health field and was trained in qualitative data collection techniques. He did not have an already established relationship with any of the interviewees and had little knowledge about water conservation technologies prior to initiating the study. While a lack of background in the subject matter area limited understanding of concepts during some of the interviews, it also allowed the researcher to ask descriptive follow-up questions of the interviewee that would have been deemed as unacceptable by someone with in-depth knowledge of the field of inquiry. In addition, the outside perspective the researcher brought to the analysis reduced bias associated with an interest in implementing certain technologies over others.

The researcher analyzing the data did have discussions with the other researchers on the team regarding sociological approaches to agricultural research since his background was in public health. The gained understanding was utilized to bridge the gap between scientific research and naturalistic inquiry. Using this approach allowed the researcher to explore barriers and motivators associated with adopting water conservation and treatment technologies from individuals with lived experiences as growers or decision-makers within nursery or greenhouse operations. The research team believed that social science theoretical frameworks could be used to uncover issues pertaining to adopting water conservation and treatment technologies and therefore this perspective was taken during data analysis.

Data Analysis

At the completion of data collection, audio recordings of each interview were transcribed in order to begin the content analysis process. Content analysis enabled the researcher to make “reliable, valid inferences from qualitative data” (Krippendorff, 2013, p. 418). Content analysis stratifies data *a priori* supporting the use of theoretical models to group data into categories (Casullo, 1999; Lincoln & Guba, 1985). This study utilized Ajzen’s (1991) TPB constructs of attitude, perceived behavioral control, and subjective norms to identify thick, rich description supporting or refuting the influence of the three theoretical components on adoption of water conservation and protection technologies.

Before conducting content analysis, the researcher reviewed the three components of the theoretical framework to develop a deep understanding of how the constructs of this model could be applied to the adoption of water conservation practices and treatment technologies in nursery and greenhouse operations throughout the United States. At the completion of data analysis, the researcher conducted a peer debrief, as suggested by Merriam (1998), with two assistant professors with a backround in extension education also working on the project to ensure the themes identified were correct, as well as to provide the group with justification as to why codes were placed into specific categories. This process was conducted to reduce research bias and ensure rigor (Lincoln

& Guba, 1985; Mays & Pope, 1995). Mays and Pope (1995) suggested that one goal of all qualitative research should be to

> create an account of method and data which can stand independently so that another trained researcher could analyze the same data in the same way and come to essentially the same conclusions; and to produce a plausible and coherent explanation of the phenomenon under scrutiny (p. 110).

The integrity and credibility of the data was upheld by creating an audit trail throughout the entire coding process (Lincoln & Guba, 1985). The researcher also produced and categorized reports from notes and photographs taken during the interviews at each facility for triangulation purposes (Lincoln & Guba, 1985).

Description of Participants

The 24 participants recruited for the project represented small-, medium-, and large-scale nursery and greenhouse operations throughout the United States (see Table 1). Only two of the participants were female and both women reported using recycled water and water treatment technologies. Only three of the operations were not using recycled water. In addition, only four of the 13 medium and large sized operations were not using water treatment technologies. On the other hand, only three of the 11 small sized operations were engaged in using water treatment technologies. The operations that were not engaged in using water treatment technologies were primarily in the west and south/southeastern parts of the United States. Pseudonyms were assigned to each participant to ensure confidentiality.

Table 1

Characteristics of Participants

Pseudonym	Gender	Size of Operation	Geographical Location	Operation uses recycled water	Water treatment used
Rhonda	Female	Large	Northeast	Yes	Acid and Chlorine
Edward	Male	Large	Northeast	Yes	Chlorine
Jason	Male	Large	Northwest	Yes	Chlorine
Tyler	Male	Large	Northwest	Yes	Chlorine
Calvin	Male	Large	West	Yes	Chlorine Dioxide
Frank	Male	Large	West	Yes	Chlorine Dioxide equipment installed- “not yet running”
Herber	Male	Large	West	No	None

Table 1 (continued)

Characteristics of Participants

Pseudonym	Gender	Size of Operation	Geographical Location	Operation uses recycled water	Water treatment used
Isaac	Male	Large	West	Yes	None
Joseph	Male	Medium	Southeast	Yes	Chlorine
Phil	Male	Medium	Southeast	Yes	Chlorine
Richard	Male	Medium	South	Yes	Chlorine
Brett	Male	Medium	West	Yes	None
Greg	Male	Medium	West	Yes	None
Adam	Male	Small	South	Yes	Chlorine
Lance	Male	Small	South	Yes	Chlorine
Katherine	Female	Small	Midwest	Yes	Hydrogen Dioxide
Ben	Male	Small	South	Yes	None
Daniel	Male	Small	South	Yes	None
Jimmy	Male	Small	South	No	None
Kenneth	Male	Small	West	No	None
Matt	Male	Small	South	Yes	None
Noah	Male	Small	South	Yes	None
Robert	Male	Small	South	Yes	None
Steve	Male	Small	Southeast	Yes	None

Results

Attitude

The first objective of the study was to explore nursery and greenhouse operators' attitude toward adopting water conservation practices and treatment technologies. Overall, the participants' attitudes towards the adoption of water conservation practices and treatment technologies were positive. The subthemes that emerged were related to *solving existing issues, reducing plant infections,* and *reducing financial and human resource costs*.

The first subtheme identifying why a participant would have a positive attitude towards the adoption of water conservation practices and treatment techonologies was they assisted in *solving existing issues*. Many of the participants were worried about running out of water. They mentioned impending drought that could result in wells drying up, they feared additional costs associated with water withdrawal from municipal sources, and they were worried about going out of business if water became unavailable. However, they felt the adoption of new technologies could positively assist with these upcoming challenges. When discussing water conservation practices in general, Caleb said, "I think what is going to save us is the fact that we can show that we are going above and beyond what the average person is doing, and contributing to water conservation." Alex said, "If restrictions are imposed and we have to reduce our water use, then to be on the proactive side of that instead of the reactive side I think is a benefit."

Other issues solved by adopting new technologies related to efficiency. Several participants explained that new technologies enhanced the efficiency of their watering practices by reducing issues with their equipment. For example Ethan noted, "the benefits of treating water is, with drip irrigation, you don't have clogged emitters." Diane stated, "It's a very efficient way to get a lot of plants watered quickly."

The second subtheme that emerged when identifying why a participant would have a positive attitude towards the adoption of water conservation practices and treatment techonologies was *reducing plant infections*. For example, when discussing water treatment and water reuse, Will stated, "[water treatment and reuse] provides us with cleaner water, which is healthy for our plants." Florence agreed when she noted, "The benefit is going to be a cleaner crop and less reliance on any kind of pesticide or fungicides." Dean also mentioned cleaner water that was safer for his plants: "It allows us to reduce our chemical usage that we spray because we eliminate one of the components of inoculation of the plants, which is the pathogen-filled water. Through chlorination we're pumping water that is basically pathogen-free."

The third subtheme that emerged was *reducing financial and human resource costs*. When discussing the financial ramifications adoption had on his business Will stated, "it's huge… probably in a quarter of a million dollar range a year… it's big dollars." When asked about the benefits of resuing water, Kurt answered, "Saving mainly pumping cost, and wear and tear on your pump, plus, electricity cost." Mike mentioned how variable frequency drives "helped with labor and efficiency." Bernie stated, "There's a big financial incentive. Even small percentage savings add up to a lot of dollars very, very quickly." When discussing lower human resources needed with new technologies, Diane said, "Having all these automated systems can minimize the number of section growers that you need because they can cover a lot more acreage with automation than hand watering."

During data analysis negative atttitudes towards adoption also emerged. The subthemes for why participants would have a negative attitude towards adoption were related to *increased issues with equipment* and *safety.*

The first subtheme identifying why a participant would have a negative attitude towards the adoption of water conservation practices and treatment techonologies was that new technologies *increased issues with equipment*. For example, when discussing impact heads, Victor stated, "They're pretty inefficient, at least that is how I feel. You're getting the spray pattern that might hit the plant or might not." When discussing the use of vegetation in storm water retention ponds, Will said, "We want to get that out… they clog up the intakes." When discussing water reuse Mike stated:

We have concerns with build up of salts, build up of pathogens, build up of organic matter, build up of weed seed…We need to make sure we are properly treating the water to ensure the plants are seeing the cleanest and healthiest water possible.

The second subtheme that emerged was *safety*. When discussing chlorine specifically, several participants had safety concerns with the dangers of fumes and gas leaks. For example, Ethan said, "Inhaling the gas chlorine while switching tanks and having accidental leaks or valves on the tanks not working properly, that's my biggest concern." Todd had not tried chlorine because "chlorine sounds dangerous, so I have yet to do that."

Perceived Behavioral Control

The second objective of the study was to explore nursery and greenhouse operators' perceived behavioral control associated with adopting water conservation practices and treatment technologies. The subthemes that emerged were *the economics associated with adoption,* the *lack of technical training,* and a *lack of infrastructure* needed to implement new technologies.

The first subtheme that emerged was the *economics associated with adoption*. This was largely due to the financial cost of the equipment, as well as the initial cost of replacing equipment that works, albeit less efficiently than the newer equipment. When asked why he still uses overheads, Will simply said, "Time and money," and (laughing) continued on to say, "That's the key to most things." Alex also stated the "cost associated" was his reason for not adopting new technologies. When Ethan was discussing why they were not using chlorine tablets, he said the reason he had not switched was "the cost of switching over right now. We already have all the equipment for doing gas, so we are just going to stick with that." Glen also mentioned the cost associated with changing techniques. He said, "We could be using more micro irrigation but we have the infrastructure in place for the overhead… It's very expensive to covert… has been prohibitively expensive." Henry stated, "The systems cost a lot because they're newer technologies. I think that's always a challenge."

However, some participants felt the implementation of water conservation techniques reduced their costs. When Victor was discussing his decision to recycle water instead of drilling more wells, he felt reuse was a more financially viable option: "It's pretty expensive to drill a well… especially if you don't hit water." Alex also discussed the available subsidies associated with implementing treatment technologies and reported they are "probably one of the most important ways that we've been able to [adopt]" and assisted them in overcoming the economic barriers associated with integrating new technologies.

The second subtheme that emerged was the *lack of technical training*. Several participants reflected on the complexity of new technology and their lack of personnel trained to operate complex systems. Mike said, "Some of the stuff gets so technical… you got to have an IT (information technology) person that's babysitting the project." Alex also had concerns about the technical side of new technologies. He stated, "The technology requires a technical maintenance person to be able to manage and keep up with the day-to-day operations…[It's all] a little bit more technologically advanced and not something [that I] as a grower can manage."

The third subtheme that emerged was a *lack of infrastructure*. Participants discussed the lack of ability to install retention ponds due to a lack of space and the inability to integrate new technologies into old systems. Several partiicpants reported they just did not have the capacity/space for the new technology. Dean stated, "Reusing is expensive, and the infrastructure of the set-up side, you have to have additional ponds and you have to have additional pumping capacity." In addition, some participants felt their existing systems were a barrier to adoption, reporting the lack of ability to integrate new technology into existing systems. For example, Glen already had the infrastructure in place for overhead sprinklers that was "developed in 1992, and the rest of the nursery was built prior to that time...so while 90 acres have controlled automated irrigation system, 450 or so do not."

Subjective Norm

The third objective of the study was to explore nursery and greenhouse operators' subjective norms associated with adopting water conservation practices and treatment technologies. The subthemes that emerged were *the culture of the industry, adopting technologies others had adopted,* doing the *right thing for society and the environment,* and *being seen as environmentally friendly.*

The first subtheme was the *culture of the industry*. Many of the participants reflected on an industry-wide mentality that plants need water; therefore, if it is available you should use it. Dean stated, "I think one of the biggest things we could do as an industry is change the mentality. We're tied in with the ag mentality to pump 24 hours a day if you have a permit." Caleb believed the agricultural community was striving to make efforts but they were not always recognized by the broader public. He said, "I think we need to look at how much water everybody is using, not just the agricultural community. I think in general ag is trying to do the right thing." Alex reiterated that by saying, "As an industry, we need to do the right things to be good stewards of the environment and have a sustainable product."

Within the second subtheme, *adopting technologies others have adopted*, participants reflected on their reliance of their fellow growers to learn about and see new technologies in action. They were more inclined to adopt a new technology if a fellow grower was already using it. For example, Mike stated, "We're a pretty close industry out here so you catch wind from a dealer or supplier of some sort if someone is trying something. You just give them a call and ask them what's up and how are they liking it." When deciding whether or not to chlorinate his water, Marion discussed "other nurseries that had done it with mixed reviews, so we decided to try it and see if there was any advantage." Will agreed when he s, "Over the years you get to know people… When I go [to their facilities], I'm looking at their irrigation system." He also discussed when others come to his facility "all they want to see is our pump houses, what we're doing, just to get ideas." Glen described his reciprocal relationship with researchers when he said, "We look at research that has been done in other places and see how it can apply to our nursery. We also sometimes invite researchers to come and do research on our property."

The third subtheme that emerged was doing the *right thing for society and the environment*. A majority of the participants reflected on this subtheme with the feeling that conserving water was the right thing to do, in general. For example Fred said, "Obviously we want to be good stewards of our land." Several participants discussed the drought California is going through and the political landscape in Oregon as examples causing them to reflect on the need to be conscious of saving water. Oliver noted, "Everybody needs to be conscious of saving water, keeping our environment clean… as we start to look at things like Oregon and California… where the state of Oregon owns every drop of water." Henry discussed being a good steward of the land makes good business sense: "You don't want to waste things that you don't need to waste. Water is definitely a precious resource that we have, and we don't want to waste it for no good reason."

The last subtheme identified was the need to *be seen as environmentally friendly*. Many of the participants reflected on their company being "environmentally conscious" [Jacob] or an "environmental steward" [Alex]. Bernie discussed his "personal bias towards water conservation. We have a company culture. I love water conservation." Several of the participants took pride in their efforts to reduce water use. For example Caleb stated, "We are heads and tails above 99 percent of the people." When describing the leadership of his company Glen said:

The leadership of the company has always focused on the quality of the plants that we grow, the quality of the work environment for our employees, and the commitment to reduce our impact on the environment. That's all come from the owners and the leadership of the company, and the people that work here understand that and have applied themselves towards those goals.

Jacob went so far as to state, "There is a certain image that we like to project to our customers that we're doing our share… Public image is very important to us." Oliver made a similar statement reiterating that, "we want our customers to know our operation, to feel that we're doing the very best we possibly can do [to conserve and protect water resources]."

Conclusions, Implications and Recommendations

Generally, participants tended to have a positive attitude towards water treatments and technologies that would assist with water quality and conservation due to their reliance on natural resources. Services delivered by extension professionals were never mentioned as a reason they had formed positive attitudes. Therefore, extension professionals should consider their roles in influencing the development of positive attitudes towards technologies and practices since they are an important link between researchers and those in the field (Tain & Diana, 2007). One important way to help growers develop more positive attitudes towards technologies and practices is to provide educational materials that present them as solutions to problems instead of focusing on how to use the technology. Growers are motivated by solutions; therefore, educational materials on innovative practices and technologies should be catalogued by the solutions they provide as opposed to being listed by the technologies themselves. For example, educational materials created to assist with adoption should emphasize the implications for improved plant health and reduced infections associated with water reuse. An increase in healthy, more salable plants will lead to more satisfied customers. Research has also shown customers are willing to pay more for sustainably grown plant materials (Behe et al., 2013; Khachatryan et al., 2014). Growers should be made aware of this demand, and encouraged to communicate the value of plant materials grown by operations committed to protecting water resources. By introducing consumer-driven demand for products grown under water-concious management practices and helping growers to market these practices, extension professionals may be able to alleviate growers' concerns related to financial risk.

The findings revealed growers believed they could benefit financially from increased efficiency and decreased operating costs as a result of reducing the amount of water they use to produce plant materials (Yeager et al., 2010). This was especially true where technologies and practices required substantial up-front costs. Communicating the long-term value of reduced costs to the operation over time may help to encourage positive attitudes. Case studies of successful growers who have reduced financial and human costs associated with hand monitoring and watering may be an effective means of communicating this value. In addition, extension professionals could assist by working with agricultural economists to conduct cost/benefit analysis for growers to demonstrate how much money they will save in the long run. Through exposure to a financial analysis of their own operation, rather than an ambiguous concept, growers may be more likely to adopt.

In addition, information about organizations that will subsidize the implementation of water-saving technologies can be shared in a simple, straightforward manner. Many growers do not apply for subsidies because of the complexity associated with the application or they may not know they are eligible and are unsure of where to begin to find out what is available. Extension professionals can assist in alleviating this gap by providing this information in an easily digestible manner on a central website that lists all opportunities, describes who is eligible and provides resources for growers to use during the application process.

Several participants were concerned with the safety and health of their workers and had fears related to adopting several new techniques, especially those related to chemicals. When recommending new techniques, extension professionals need to be very transparent about the safety risks associated with adoption. Individuals are often afraid of what they do not know or what they perceive as being hidden from them. Acknowledging risks and offering clear, simple ways to mitigate them during implementation should assist in adoption.

Extension professionals need to keep in mind the challenges associated with adoption of complex systems when developing new technologies and communicate this with the researchers they work with closely. The progression of science often moves more quickly than what is easily adopted, as shown in these findings. Researchers need to be made aware that increased efficiency does not always mean the technology is useful. This research implies researchers and extension professionals need to work together with growers, starting with a technology that has a low complexity level, and then gradually introduce more complex systems as growers and their staff become comfortable. The findings also imply complications with using new technologies may lead to negative attitudes. Given this extension professionals need to work to reduce the likelihood that growers experience problems with new techniques. One way to do this is through providing clear instructions for installation with minimal complications. Troubleshooting guides, developed in collaboration with researchers, could assist in reducing the likelihood of issues with new equipment, such as clogged pipes, blocked emitters, and chlorine leaks.

In addition to addressing the complexities of new systems, researchers need to consider the need to integrate new technologies with old systems and structures, including ensuring the new technology is flexible and can be easily integrated into multiple types of systems. Many growers have aging systems and cannot afford to completely renovate; therefore, they have a need for new technologies that can be integrated into older systems and buildings. Perhaps, prior to development, extension professionals could assist researchers in conducting a needs assessment with targeted growers to determine their current equipment status and comfort level with new technologies. This information could be used to identify the types of technologies that would be compatible and worth the time and expense of the development process. In addition, the needs assessment data could be used to assist in the development of training materials that fit the ability level of the targeted growers. Solutions to technical problems could be offered through online instruction, infographics and/or YouTube videos. However, before investing the time in these new materials, extension professionals should determine whether or not these are learning material transfer methods growers among their target audience would use if they were offered.

Extension professionals should also consider the powerful influence of subjective norms among this audience and recognize that changes within individual operations are strongly connected to what others are doing and the culture of the industry. A strong industry culture is present, and shifting the industry as a whole is extremely difficult. However, when the industry is challenged by an issue, such as limited water availability, there is a great opportunity to bring people together to discuss the issue with the potential for industry-wide shifts in culture. Extension professionals are uniquely positioned to serve as change agents in these critical environments

(Rogers, 2003), bridging researchers and growers by creating meeting spaces where the two groups can get together and come up with collaborative solutions.

Similar to Oskamp et al. (1991), the findings of this study found growers were stimulated by what their peers are doing, what their peers believe is useful and what their peers believe is worth the time and financial investment. To make use of strong social ties, outreach and demonstration opportunities should be developed at grower facilities, rather than research facilities to show how peers are using technologies. Growers who have adopted new strategies should be encouraged to discuss their use of water technologies and practices openly and freely with their peers and also to share their results within their social group. In addition, the case studies previously recommended could also be used as a way to communicate the value of adopting practices and technologies and used to highlight adoption among growers' peers. The case studies could be used to help communicate a new social norm which would unite growers around water stewardship.

Finally, since growers naturally see themselves as stewards of the land, extension professionals should use this to encourage growers to protect water resources. The personal impact individual growers can make on the environment through their adoption should be emphasized and promoted. Extension professionals can enable growers and activate their connection to the land by showing them how their individual efforts are helping the rest of their community, ensuring future water resources are available for generations to come.

While growers can and must take action to help the environment, their businesses may benefit from protecting water resources, and they are motivated by the image they project among their customers. Growers are "by nature generally conservative and often reticent in telling others about their accomplishments, but communicating how and why we are effective managers of water is in many ways the most critical" elements of successful stewardship of water (Mezitt, 1992, p. 83). Growers need help in understanding the value and benefits of sustainability in order to communicate the value of sustainably grown products to customers (Hall et al., 2009). Because the image of water stewardship is so important to growers, extension professionals should provide assistance in creating marketing campaigns and strategies that emphasize their protection of natural resources.

The findings presented here point to opportunities for further research. It is important to recognize that all qualitative research comes with limitations and cannot be interpreted beyond the specific group studied. Therefore, it is recommended a survey of nursery and greenhouse growers be designed in order to collect data that can be generalized. This survey would be an important step in defining why growers do and do not choose to adopt new water-saving technologies and can further assist in developing educational materials and approaches that encourage adoption.

A generalizable survey would also allow for an examination of regional differences so extension programs could be targeted, depending on where a scientist or extension professional is working. With a larger population, distinct differences in adoption barriers and enablers could be identified, based on the size of the operation, the types of plants being grown, and the purpose of the business. For example, perhaps growers who produce shade trees and buffer plants experience different barriers to adoption than those primarily focused on floriculture for aesthetic purposes. Additionally, growers providing plants for the home landscape may be more motivated to adopt sustainable solutions because their customers desire plants grown this way.

In addition to the survey, it is suggested research be done to quantify financial water savings obtained by growers that have adopted new technologies to inform future technological development. Perhaps several case studies could be undertaken at diverse operations detailing changes in finances over time related to adoption. Finally, this study targeted nursery and greenhouse growers; however, the findings may be applied to the agriculture industry as a whole. While the greenhouse and nursery grower industry has certain water conservation technologies that are specifically suited for their equipment, water conservation and protection techniques should be broadly adopted. Some of the barriers identified in this research may assist in informing how extension professionals can go about encouraging adoption in other areas with different technologies.

References

Ahnström, J., Höckert, J., Bergeå, H. L., Francis, C. A., Skelton, P., & Hallgren, L. (2009). Farmers and nature conservation: What is known about attitudes, context factors and actions affecting conservation? *Renewable Agriculture and Food Systems, 24*(1), 38–47. doi:10.1017/S1742170508002391

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2),179–211. doi:10.1016/0749-5978(91)90020-T

Beedell, J. D. C., & Rehman, T. (1999). Explaining farmers' conservation behaviour: Why do farmers behave the way they do? *Journal of Environmental Management, 57*(3), 165–76. doi:10.1006/jema.1999.0296

Behe, B., Campbell, B., Hall, C., Khachatryan, H., Dennis, J., & Yue, C. (2013). Consumer preferences for local and sustainable plant production characteristics. *HortScience, 48*(2), 200–08.

Blaine, T. W., Clayton, S., Robbins, P., & Grewal, P.S. (2012). Homeowner attitudes and practices towards residential landscape management in Ohio, USA. *Environmental Management, 50*(2), 257–71.

Breukers, A., van Asseldonk, M., Bremmer, J., & Beekman, V. (2012). Understanding growers' decisions to manage invasive pathogens at the farm level. *Phytopathology, 102*(6), 609–19.

Casullo, A. (Ed). (1999). *A priori knowledge.* International Research Library of Philosophy, Aldershot, UK.

Dennis, J., Lopez, R., Behe, B., Hall, C., Yue, C., & Campbell, B. (2010). Sustainable production practices adopted by greenhouse and nursery plant growers. *HortScience, 45*(8), 1232–37.

DiCicco-Bloom, B. & Crabtree, B. F. (2006). The qualitative research interview. *Journal of Medical Education, 40,* 314-321.

Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on attitude-behavior relationships: A natural experiment with curbside recycling. *Environment and Behavior, 27*(5), 699-718. doi:10.1177/0013916595275005

Hall, T. J., Dennis, J. H., Lopez, R. G., & Marshall, M. I. (2009). Factors affecting growers' willingness to adopt sustainable floriculture practices. *HortScience, 44*(5), 1346–51. Retrieved from http://hortsci.ashspublications.org/content/44/5/1346.full

Hodges, A. W., Khachatryan, H., Hall, C. R., & Palma, M. A. (2015). Trade flows and marketing practices within the U.S. Nursery Industry, 2013. *Southern Cooperative Series Bulletin #420.* Retrieved from http://saaesd.ncsu.edu/docs/National%20Green%20Industry%20Survey%20report%202014%20SCSB%2052615.pdf

Khachatryan, H., Campbell, B., Hall, C., Behe, B., Yue, C., & Dennis, J. (2014). The effects of individual environmental concerns on willingness to pay for sustainable plant attributes. *HortScience, 49*(1), 69–75.

Kratsch, H. A., Ward, R., Shao, M., & Rupp, L.A. (2010). Educational needs and perspectives on the future of the Green Industry in Utah. *HortTechnology, 20*, 381–88. Retrieved from http://horttech.ashspublications.org/content/20/2/381.full.pdf+html?sid=7588d03a-b6e4-4461-a88f-5b492ac023aa

Krippendorff, K. (2013). *Content analysis: An introduction to its methodology* (3rd ed.). London, UK: Sage.

Lam, S. (1999). Predicting intentions to conserve water from the theory of planned behavior, perceived moral obligation, and perceived water right. *Journal of Applied Social Psychology, 29*(5), 1058–71. doi:10.1111/j.1559-1816.1999.tb00140.x

Lamm, A. J., Lamm, K. W., & Strickland, L. R. (2013). Focusing on the future: Understanding faculty intent to lead the land grant system. *Journal of Agricultural Education, 56*(3), 92-103. DOI: 10.5032/jae.2013.04092

Lea-Cox, J. D., Zhao, C., Ross, D. S., Bilderback, T. E., Harris, J. R., Day, S. D., et al., & Ruter, J. M. (2010). A nursery and greenhouse online knowledge center: learning opportunities for sustainable practice. *HortTechnology, 20*(3), 509–17.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publication, Inc.

Lubell, M., Niles, M., & Hoffman, M. (2014). Extension 3.0: Managing agricultural knowledge systems in the network age. *Society and Natural Resources, 27*(10), 1089-1103. Doi:10.1080/08941920.2014.933496.

Lynne, G. D., Franklin Casey, C., Hodges, A., & Rahmani, M. (1995). Conservation technology adoption decisions and the theory of planned behavior. *Journal of Economic Psychology, 16*(4), 581–98. doi:10.1016/0167-4870(95)00031-6

Mays, N. & Pope, C. (1995). Rigour and qualitative research. *British Medical Journal, 311*(6997), 109-112.

Merriam, S. (1988). *Case study research in education: A qualitative approach*. San Francisco, CA: Jossey-Bass.

Mezitt, R. W. (1992). Nursery operator's perspective on water quality impact. *HortTechnology, 2*, 82–83. Retrieved from http://horttech.ashspublications.org/content/2/1/82.full.pdf+html?sid=7588d03a-b6e4-4461-a88f-5b492ac023aa

Myers, B. E., & Washburn, S. G. (2008). Integrating science in the agriculture curriculum: Agriculture teacher perceptions of the opportunities, barriers, and impact on student enrollment. *Journal of Agricultural Education, 49*(2), 27-37. doi: 10.5032/jae.2008.02027

Oskamp, S., Harrington, M. J., Edwards, T. C., Sherwood, D. L., Okuda, S. M., & Swanson, D. C. (1991). Factors influencing household recycling behavior. *Environment and Behavior, 23*, 494–519. doi: 10.1177/0013916591234005

Roberts, T. G., Harder, A., & Brashears, M. T. (Eds). (2016). *American Association for Agricultural Education national research agenda: 2016-2020.* Gainesville, FL: Department of Agricultural Education and Communication.

Rossi Borgers, J., Oude Lansink, A., Ribeiro, C., & Lutke, V. (2014). Understanding farmers' intention to adopt improved natural grassland using the theory of planned behavior. *Livestock Science, 169*, 163–74. doi:10.1016/j.livsci.2014.09.014

Schaible, G., & Aillery, M. (2012). Water conservation in irrigated agriculture: Trends and challenges in the face of emerging demands. *USDA-ERS Economic Information Bulletin No. 99*. Retrieved from http://ssrn.com/abstract=2186555

Staats, H. L., Jansen, J., & Thøgersen, J. (2011). Greening the greenhouse grower. A behavioral analysis of a sector-initiated system to reduce the environmental load of greenhouses. *Journal of Environmental Management, 92*(10), 2461–69. Retrieved from http://www.sciencedirect.com/science/article/pii/S0301479711001629

Tain, F. H., & Diana, J.S. (2007). Impacts of extension practice: Lessons from small farm-based aquaculture of Nile Tilapia in northeastern Thailand. *Society and Natural Resources, 20*(7), 583-595. Doi: 10.1080/08941920601171824

Trumbo, C. W., & O'Keefe, G. J. (2001). Intention to conserve water: Environmental values, planned behavior, and information effects. A comparison of three communities sharing a watershed. *Society and Natural Resources, 14*(10), 889–899.

Warner, L. A., Rumble, J., Martin, E., Lamm, A. J., & Cantrell, R. (2015). The effect of strategic message selection on residents' intent to conserve water in the landscape. *Journal of Agricultural Education, 56*(4), 59 - 74. doi: 10.5032/jae.2015.04059

Yeager, T., Million, J., Larsen, C., & Stamps, B. (2010). Florida nursery best management practices: Past, present, and future. *HortTechnology, 20*, 82–88. Retreived from http://horttech.ashspublications.org/content/20/1/82.full?sid=f4281d42-cb80-4504-afdb-13da3e4bb847