ADDRESSING WATER QUALITY MITIGATION CHALLENGES THROUGH EVALUATION

A Dissertation

by

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ABSTRACT

The Arroyo Colorado River currently does not meet the State of Texas' criteria for water quality. As a result, the Arroyo Colorado Watershed Protection Plan was developed, and implementation of the plan has been ongoing since 2007. Over the last few years, attendance at meetings and participation in education and incentive programs have decreased. Water quality can be restored only with individual participation; however, there has been a lack of information available to individuals to properly implement the Plan.

This study sought to collect data that will ultimately prioritize implementation efforts of the Arroyo Colorado Watershed Protection Plan. The research was conducted with agricultural producers in three counties of the Lower Rio Grande Valley of Texas: Cameron, Hidalgo, and Willacy counties.

Research questions for this study were 1) What are the primary educational needs for agricultural producers in Cameron, Hidalgo, and Willacy counties related to water, 2) What are the primary barriers to management practice adoption through incentive programs, and 3) What areas of the agricultural component of the Arroyo Colorado Watershed Protection Plan have been implemented effectively according to agricultural producer perception? Sixteen, eighteen, and twelve manifest variables (measurable variables), respectively, made up the primary constructs of this study. Of the 1,200 participants selected for this study, 63 questionnaires were undeliverable and 274

participants responded, resulting in a 24.1% response rate. Data were collected using mailed and internet surveys.

Results indicated that water quantity related variables were the primary educational need, followed by water quality, financial incentives, and conservation practice manifest variables. Primary barriers were related to economic manifest variables, followed by information/awareness, programmatic, and producer/operation. Finally, results indicated that education was the most effective component of the program, followed by technical assistance, cost-share assistance, and monitoring and assessment. Further, significant differences between levels of various demographic variables could be identified in participants' response to manifest variables. A key finding was that those who have heard of the Arroyo Colorado Watershed Protection Plan were more likely to have responded as having adopted sustainable agricultural practices than those who had not heard of the Plan.

Recommendations were made for education programs to focus on water quantity while bringing in aspects of water quality, followed by technical aspects of financial incentives and conservation practices. Avoiding barriers should consist of revising cost-share levels for the initial cost of installation and ensuring that cost-share assistance is readily available when it is requested. Finally, to improve the program, monitoring and assessment projects should do a better job of relaying information about conservation practice effectiveness, which also ties back into some of the barriers and educational needs related to water.

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To the Texas State Soil and Water Conservation Board, the Texas Commission on Environmental Quality, and the United States Environmental Protection Agency, thank you for providing the opportunity and monetary support for my research project. The results of this research project will hopefully be used to continue enhancing local programs and gaining community support for implementation.

Finally, I would like to thank all of the agricultural producers that responded to the survey. It is only because of participation from people like you that we can complete research projects such as this and also use results from these projects to improve our efforts in your area.

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CHAPTER I

INTRODUCTION

Using Educational Needs, Barriers to Adoption, and Program Evaluation to Improve Watershed Implementation in the Lower Rio Grande Valley of Texas

The Federal Clean Water Act §303 (United States Environmental Protection Agency, 2012) requires that states identify how water bodies in the state are used and establish criteria, or standards, needed to sustain those uses. To determine which water bodies do not meet the standards, the state is required to monitor for various parameters and report the findings. If water bodies do not meet the set standards, they are placed on what is commonly referred to as the 303(d) List, named after §303(d) of the Clean Water Act. In Texas, this is known as the *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*. Houck (1999) describes that once water bodies have been added to the 303(d) List, §303(d) of the Clean Water Act requires states to:

1. Pinpoint water bodies that will still be polluted even after available technology has been applied.
2. Highlight the water bodies while taking into account the severity of their contamination; and
3. Develop "total maximum daily loads" that take into account seasonality, economic growth, and a margin of safety to determine the maximum amount of pollution that a water body can receive and still meet water quality standards.

Watershed based plans, whether they be a Watershed Protection Plan (WPP) or Total Maximum Daily Load (TMDL) and Implementation Plan, have been developed across Texas. Figure 1 provides an overview of Watershed Protection Plans and Total Maximum Daily Loads that have been adopted statewide.

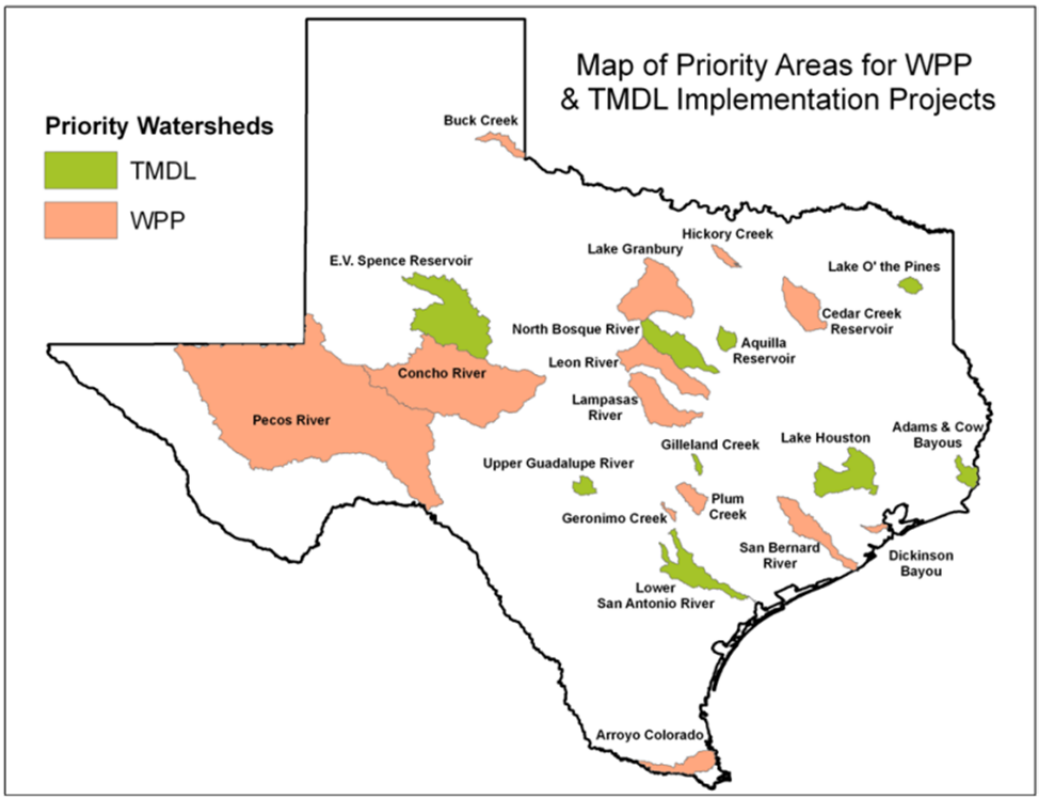

Figure 1. Map of WPPs and TMDLs in Texas

Agriculture has been identified as the primary contributor to nonpoint source pollution (United States Environmental Protection Agency, 2012) in the United States, and currently, there are no permitting methods or regulations for this source. The Texas Agricultural Code, §201.026, which contains information about nonpoint source

pollution, charges the state board as the primary agency for activity relating to mitigation of agricultural and silvicultural (forestry) nonpoint source pollution. Specifically, this is done through voluntary efforts of planning, implementing, and managing programs and practices that reduce sources of pollution (FindLaw, 2013). Named the Texas State Soil and Water Conservation Board (TSSWCB), this agency, along with other agencies in the state, take a watershed approach to prioritize efforts where nonpoint source pollution from agricultural and silvicultural activities have been identified as causing water quality impairments (Texas State Soil and Water Conservation Board, 2010). The TSSWCB's primary means for implementing agricultural management practices is through an incentive program called the Water Quality Management Planning Program, as directed by Texas Senate Bill 503 (Texas State Soil and Water Conservation Board, 2010). A Water Quality Management Plan is a plan developed by the landowner and the local Soil and Water Conservation District (SWCD) that, according to the TSSWCB (2010) Reference Guide, includes "appropriate land treatment practices, production practices, management measures, technologies or combinations thereof." The Water Quality Management Plan must be approved both at the local level and at the state level (Texas State Soil and Water Conservation Board, 2010). Further, other incentive programs, such as the United States Department of Agriculture-Natural Resource Conservation Service (USDA-NRCS) Environmental Quality Incentives Program (EQIP), are available to landowners to help pay for the adoption of sustainable agricultural practices. Challenges have become apparent in some areas of the state due to the lack of participation in incentive programs and lack of adoption of sustainable agricultural practices. These

challenges are partially related to economic, programmatic, information and awareness, and other social barriers. An assessment of educational needs and barriers to sustainable agricultural practice adoption is important to increase the effectiveness of the overall efforts. Additionally, an evaluation of the overall implementation effort is needed to determine what has been effective, what has been ineffective, and what areas of an implementation program need to be enhanced.

The Arroyo Colorado River is located in Cameron, Hidalgo, and Willacy counties in the Lower Rio Grande Valley of South Texas. The Arroyo Colorado flows for approximately 90 miles, beginning west of McAllen, transecting Hidalgo and Cameron counties and forming the boundary for Cameron and Willacy counties for the last 16 miles, until it reaches the Lower Laguna Madre. To the Lower Laguna Madre, the Arroyo Colorado is the primary source of fresh water and serves as a nursery for aquatic life (Arroyo Colorado Watershed Partnership, 2007). The land that drains into the Arroyo Colorado is known as the Arroyo Colorado Watershed. This watershed is approximately 706 square miles and provides various land uses. Those land uses have been classified by the Spatial Sciences Lab of Texas A&M University at College Station. Primary land uses include agriculture (54%), range (18.5%), urban (12%), water bodies (6%) and sugarcane (4%) (Kannan, 2012); however, vegetable and fruit crops are grown in portions of the watershed and other types of industry exist. Two of the primary users of water in the watershed are agriculture and municipalities, and flow in the Arroyo Colorado is primarily sustained by wastewater discharges and agricultural irrigation return flows; thus, the Arroyo Colorado serves as a conveyer of this water as it

leaves the system. When wastewater discharges and agricultural return flows enter the Arroyo Colorado, they carry nutrients, sediment and bacteria, which pose a threat to the various users of the water.

The tidal segment of the Arroyo Colorado was first listed as having low levels of dissolved oxygen in 1996 and elevated levels of bacteria in 2006, while the above tidal segment was listed in 1996 for having elevated levels of bacteria (Texas Commission on Environmental Quality, 2013). As a result, an attempt to develop a total maximum daily load was initiated in 1998 to address the depressed dissolved oxygen impairment where results indicated that a near 90% reduction in pollutants would be needed (Arroyo Colorado Watershed Partnership, 2007). The Texas Commission on Environmental Quality (TCEQ) Commissioners determined that this was unattainable and the Watershed Protection Planning process began for the Arroyo Colorado watershed. The Arroyo Colorado Watershed Partnership was formed from two small groups that were developed during the Total Maximum Daily Load process of a Science and Technology Advisory Committee and Steering Committee to address the diverse contributors of pollution in the water body. The makeup of this partnership consisted of various key workgroups including 1) wastewater infrastructure, 2) agricultural issues, 3) habitat restoration, and 4) outreach and education (Arroyo Colorado Watershed Partnership, 2007). Some members of the workgroups, as well as a diverse group of other individuals, make up the Steering Committee, a group charged with making consensus decisions that represent all interests of the watershed.

Several workgroups developed recommendations in the form of technical documents, and portions of those were incorporated into the Arroyo Colorado Watershed Protection Plan (Phase I). The workgroup plans included the Arroyo Colorado Habitat Restoration Plan (2006), the Arroyo Colorado Watershed Partnership Education and Outreach Campaign (2006), and the Arroyo Colorado Watershed Protection Plan: Components Addressing Agricultural Nonpoint Source Pollution (2007). Within the Agricultural Issues Workgroup recommendations, a goal was established to "encourage the voluntary adoption of best management practices (BMPs) to reduce suspended sediment levels resulting from cropland erosion, BOD (oxygen demanding organic material) from runoff crop residue, and nitrogen and phosphorus fertilizer runoff from irrigated croplands" (Agricultural Issues Work Group of the Arroyo Colorado Watershed Partnership, 2006). In an effort to achieve the goal, it was estimated that the voluntary adoption of BMPs on irrigated lands would be needed on approximately 150,000 acres, or 50% of total irrigated acreage in the watershed. As of 2007, voluntary BMPs had already been implemented on approximately 50,000 acres through the TSSWCB's Water Quality Management Plan Program and the USDA –NRCS EQIP; thus one-third of the goal had already been achieved (Agricultural Issues Work Group of the Arroyo Colorado Watershed Partnership, 2006). To accomplish the remaining two-thirds, the Agricultural Issues Workgroup (2006) proposed four types of additional assistance that would help reach the remaining acreage needed. Those types of assistance were:

- Technical Assistance – assistance in developing farm plans for individual landowners

- Cost-Share Assistance – payments to the producer to help implement sustainable agricultural practices
- Educational Programs – informative programs that would help producers become familiar with incentive programs, management practices, and other production methods; and
- Monitoring and Assessment – determining the contribution resulting from agricultural practices and demonstrate best management practices and their benefit.

The Agricultural Issues Workgroup (2006) developed a timeline of 10,000 acres annually that owners and managers would need to implement management practices on to reach the goal. The workgroup also recommended specific practices that would need to be adopted to reach the targeted load reductions. Finally, the workgroup determined cost estimates (Table 1) for the four types of assistance for the short term and long term that would be needed to reach the goals.

Table 1

2007 Cost Estimates of the Agricultural Issues Workgroup (2006)

Type of Assistance	Short-Term Estimate (2005 - 2010)	Long-Term Estimate (2010 - 2015)
Technical Assistance	$475,000	$500,000
Cost-Share Assistance	$2.7 Million	$3 Million
Information/Education	$275,000	$300,000
Monitoring and Assessment	$750,000	$800,000
Total	$4.2 Million	$4.6 Million

As a result of the Arroyo Colorado Watershed Protection Plan, several projects have been developed for implementation and funded by various agencies, including, but not limited to, the Texas General Land Office (GLO), TCEQ, the TSSWCB, and the United States Environmental Protection Agency (US-EPA). These projects have had a wide array of focuses such as cost-share education for agricultural producers, public service announcements promoting a soil testing campaign, pesticide education, cost-share assistance, technical assistance, monitoring of irrigation BMPs, and computer modeling that simulates the effectiveness of sustainable agricultural practices. As of Fall 2012, sustainable agricultural practices had been applied to 103,604 acres, falling short of the anticipated goal (R. Ramirez, personal communication, November 20, 2012). The various projects mentioned can be categorized into one of three types that 1) educate agricultural producers, 2) assist producers in paying for the implementation of specific practices, or 3) monitor and assess the effectiveness of individual practices.

Acreage brought under sustainable practices and involvement in the agricultural issues workgroup have been declining steadily. In some workgroup meetings, individuals have mentioned that 1) educational programs have been irrelevant or not beneficial, 2) there are a variety of barriers to adopting practices, or 3) the overall effectiveness of the program is not where it needs to be. As a result of this, watershed managers have devoted time and effort to re-engage landowners to continue implementing the Arroyo Colorado Watershed Protection Plan. It is the purpose of this paper to propose a strategy to target implementation efforts in the Arroyo Colorado Watershed.

As the US-EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (2008) mentions, you can have a great plan; however, you need to implement that plan. Deciding how to implement your plan can be a difficult task. The last chapter of the handbook discusses what to do with a completed watershed plan. It discusses that you should begin with developing an organizational structure that will implement the watershed plan by using the skills that stakeholders have and identifying gaps that may exist and filling those gaps. To implement specific activities, the handbook recommends that technical assistance be available for all management measures and that training and follow up be provided. Financial mechanisms, progress tracking, and communicating results are also considered important components to implementing watershed-based plans. Finally, the handbook recommends that managers evaluate the program. Most literature focuses on developing organizational structure through collaborative watershed management, which was conducted in the Arroyo Colorado through development of the Partnership; however, the purpose of this paper is to present a way to prioritize implementation activities. Brezonik, Easter, Hatch, Mulla, and Perry (1999) do a good job of outlining the watershed management process that is currently followed in the Arroyo Colorado watershed; however, there have been issues in actually implementing the practices.

Figure 2 presents a conceptual model for implementing watershed programs. Following a similar method of how watershed plans are implemented, this conceptual model identifies three intermediate steps that should be considered so watershed implementation efforts can be effective.

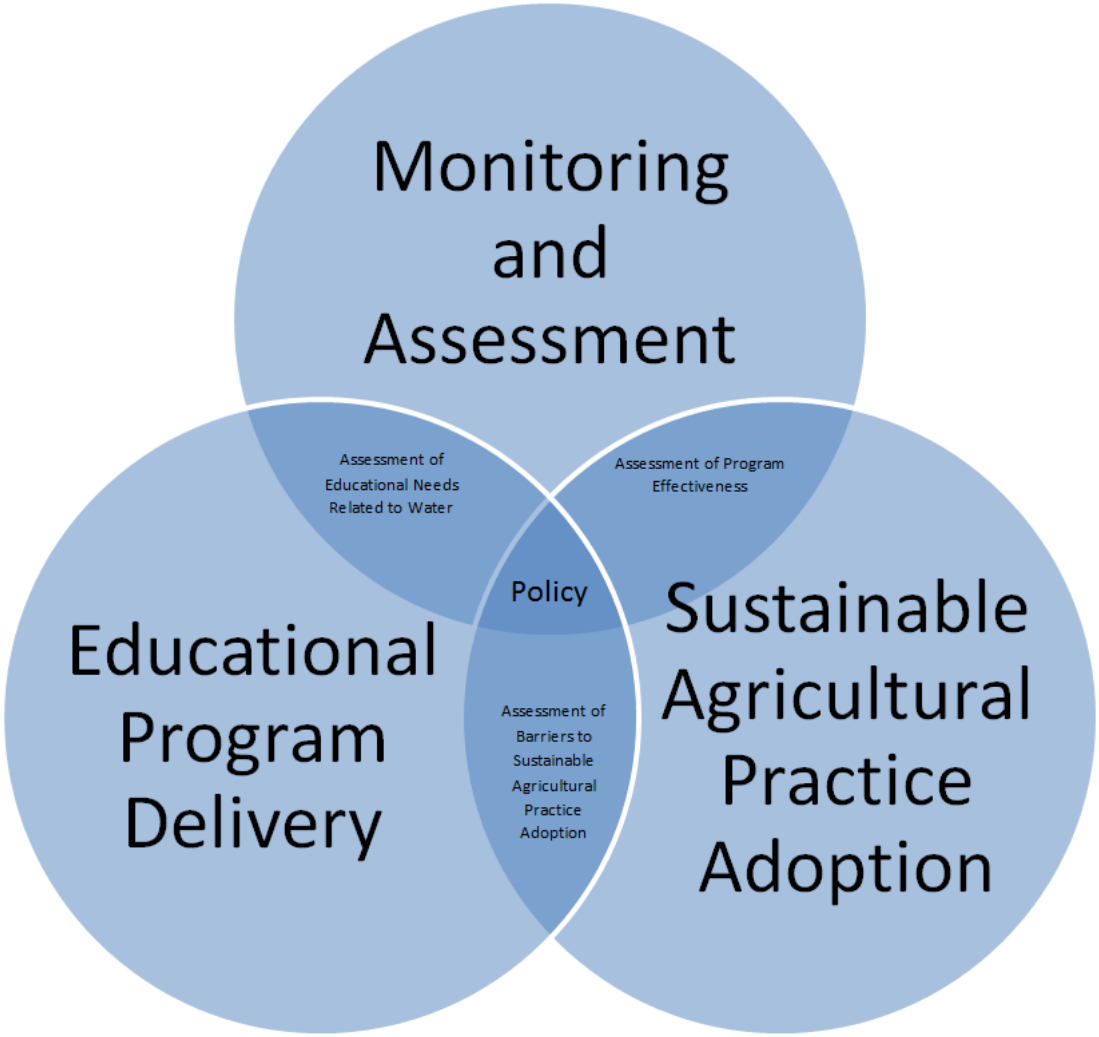

Figure 2. Conceptual model of implementing watershed programs

First, the state begins with monitoring water bodies statewide. As discussed earlier, when the water body has been identified as being impaired and a plan is developed, agricultural producers are educated on what can be done to mitigate pollutant contributors. The first intermediate step of identifying educational needs of agricultural producers related to water and delivering those programs would not only increase

attendance at educational programs and encourage implementation, but would also give agencies the opportunity to make producers aware of the overall goals of projects and what potential implications could be. When developing educational programs, educators should keep in mind Knowles (1980) four assumptions (1. As a person matures, his/her self-concept moves from being a dependent learner to one that is self-directed, 2. As an adult learns, they have experience that is a resource for learning, 3. The readiness of an adult to learn is tied with their social role, and 4. Adults tend to be problem centered rather than subject centered), and later two others (5. Adults are usually motivated by internal rather than external factors, 6. Adults need to know why they need to learn something) (Knowles, 1984) to adult learning and Rogers (2003) components of an innovation (relative advantage, compatibility, complexity, observability, trialability).

Second, Texas addresses sources of pollution from agricultural lands in the form of voluntary conservation plans, typically through TSSWCB, USDA-NRCS, or United States Department of Agriculture Farm Services Administration (USDA-FSA) incentive programs, because nonpoint sources of pollution are not regulated. Understanding the barriers to adopting practices through incentive programs is important for agencies and would be conducted in the second intermediate step. If funds are available to producers but very few are adopting practices through incentive programs, agencies must understand the reasons why so that the program can be made more available/enticing to producers.

Finally, the state continues to assess the water body over a period of time to evaluate the impact of the program on water quality. The ultimate goal would be to meet

water quality standards. During watershed plan implementation, not only is water quality important, but also the perception of the stakeholder group is important because it is people who make changes, and water quality reacts to these changes; therefore, the perception of the watershed program should be measured during implementation. In conducting a program evaluation, strengths and weaknesses can be identified so that future implementation will be more effective, ultimately improving water quality.

All three cornerstones and intermediate steps help to drive policy favorable to reaching program goals. Data collection for all three intermediate steps can occur simultaneously and at any point in the implementation process; however, it is recommended that educational needs and barriers to adoption be collected at the beginning of the implementation process.

This same method of implementation extends beyond agricultural water quality mitigation efforts, as it can also be applied in an urban context, and even spill over into water quantity programs. As with any program, a problem is identified through monitoring. Individuals are then educated on the problem and what can be done to resolve it (usually through changing behavior). They are then encouraged to change behavior. After change in behavior has occurred over a period of time, the program is evaluated to determine its effectiveness. The three intermediate steps can also be applied to programs beyond those related to water quality.

As previously mentioned, the agricultural component of the Arroyo Colorado Watershed Protection Plan has been implemented for several years and has not reached the success that was originally anticipated. A variety of factors can be blamed for this

result; however, it is unknown which has contributed the most. Meeting the needs of individuals who will actually be implementing practices is the most important aspect of watershed plan implementation. Through the proposed method, watershed managers can do a better job of meeting the needs of constituents and have a larger impact on water quality. This research aims to identify those needs so that future implementation can be prioritized.

Overview of the Study

Research Design

The researcher developed a survey instrument that was completed by selected agricultural producers, both electronically and hard copy, to address the following research questions:

1. What are the primary educational needs for agricultural producers in Cameron, Hidalgo, and Willacy counties related to water?
2. What are the primary barriers to management practice adoption through incentive programs?
3. What areas of the agricultural component of the Arroyo Colorado Watershed Protection Plan have been implemented effectively according to agricultural producer perception?

The survey was completed via mailed or web survey by members of the population, based upon their preference. Returned mailed surveys were entered into a database and aggregated with web based survey results.

Population and Sample

The target population in this study was agricultural producers in Cameron, Hidalgo, and Willacy counties; however, contact information for the entire population does not exist. As such, contact information was acquired from the USDA-FSA Farm Payment Files Information database and mailing lists from local Texas A&M AgriLife County Extension Agents and aggregated into a single spreadsheet, providing a sampling frame of 2,547 producers. A random sample of 1,200 producers was selected from the population by assigning a random number to each of the individuals in the database. These random numbers were then sorted in priority order from the lowest random number assigned to the highest random number assigned and the first 1,200 were selected for sampling.

Data Collection

The researcher notified each individual in the sample of their selection to be involved in this study through a mailed postcard containing a web link to the instrument. Participants were allowed one week to complete the survey electronically. When the week had passed, the researcher mailed a hard copy of the evaluation along with a cover letter to potential participants. Two weeks after the hard copy evaluation was mailed, a reminder post card was mailed to participants that also contained a web link to the instrument, giving them the option to complete the evaluation electronically or return the hard copy version. Also, if a replacement evaluation was needed, participants had the option to request another copy. Finally, two weeks after the reminder post card was mailed, a final hard copy of the evaluation was mailed to research participants who had

not previously completed the evaluation. Participants were asked to add their address to the top of the evaluation so that they could be deleted from the mailing list when their survey was received. This occurred after each of the mailings so that evaluations were not mailed multiple times to those who had already participated or did not wish to participate. In general, the data collection process followed Dillman's (2000) Tailored Design Method.

Instrumentation

For this study, the same instrument was used in electronic format and the mailed survey. The instrument contained two questions for participants to provide optional information about the ownership of acres under production and the type of cropping system used on the acres. Sixteen questions that requested information about the perceived educational needs of agricultural producers were asked in a Likert Scale with six response options: Strongly Agree (1), Agree (2), Somewhat Agree (3), Somewhat Disagree (4), Disagree (5), and Strongly Disagree (6). These questions were arranged so that the first four questions were related to water quality, questions five through eight were related to conservation practices, questions nine through twelve were related to financial incentives, and questions thirteen through sixteen were related to water quantity. An optional text response was included for participants to include any other educational needs that may not have been included in the questions above.

Two questions requested information about whether producers have adopted management practices and used incentive programs in the past. These two questions contain "yes", "no but I intend to", and "no and I do not intend to options".

Eighteen questions with the same Likert Scale as above were asked that relate to the barriers of management practice adoption. These questions were arranged such that the first four were related to financial barriers, questions five through eight related to programmatic barriers, questions nine through twelve related to information/awareness barriers, and questions thirteen through eighteen were related to producer/operation barriers. An optional text response was included for participants to include any other barriers that may not have included in the questions above.

Twelve questions were then asked that related to program evaluation. The first three were related to educational components of the program, questions four though six were related to cost-share assistance aspects of the program, questions seven through nine were related to technical assistance components of the program, and questions ten through twelve were related to monitoring and assessment components. Next, participants were asked where they would like to see more focus in regard to the four components mentioned above, and the same Likert Scale was used. Following this, respondents had the option to include their thoughts on other types of programs that were needed in a text response.

A yes/no question was asked about whether the participant had heard of the Arroyo Colorado Watershed Partnership, followed by four questions that specifically related to the Arroyo Colorado Watershed Protection Plan and Partnership. Finally, demographic questions were asked that related to age, gender, ethnicity, and level of education.

Data Analysis

Statistical Package for Social Sciences (SPSS) Version 22 was used for data analysis. Descriptive statistics and factorial Analysis of Variance (ANOVA) were used to describe and summarize the data for each of the three constructs (educational needs, barriers, and program evaluation). Cronbach's coefficient alpha was calculated for each of the constructs and manifest variables to assess internal consistency. Further, each of the variables under the three constructs was subjected to similar statistical analysis, which is described below. Confidence intervals and tests for statistical significance were set *a priori* at the 0.95 and 0.05 levels, respectively.

Educational needs. Descriptive statistics of demographic information and overall educational need variables were presented. Manifest variables (measurable variables) were combined into latent variables (construct variables) and also presented with descriptive statistics. Using a factorial ANOVA, descriptive statistics were compared to manifest and latent variables to identify statistically significant differences. Differences existed, so post hoc analysis was conducted.

Barriers to adoption. The question of whether individuals had adopted or not were transformed into a dichotomous variable to differentiate between those who had and had not adopted sustainable agricultural practices. Also, manifest variables were combined into latent variables. Descriptive statistics for each of the manifest and latent variables were presented. Using a factorial ANOVA, demographics were compared to all latent and manifest variables to identify statistically significant differences. Also, the dependent variable of whether producers have adopted or not will be compared to

manifest and latent variables to identify statistically significant differences. Where differences existed, post hoc analysis was conducted.

Program evaluation. Descriptive statistics were conducted for demographic information, manifest, and latent variables. An ANOVA was conducted to determine if there were any differences between those who have heard of the Arroyo Colorado Watershed Protection Plan and those who have not in their response to manifest variables. An ANOVA was also conducted to determine if differences existed between demographics and the responses to whether participants had heard of the Plan. A factorial ANOVA was conducted to identify differences between participant responses to hearing of the Plan and latent and manifest variables. Finally, a factorial ANOVA was conducted to determine if there was a difference between those who had and had not heard of the plan in their response to having adopted sustainable practices.

Purpose of Study

The purpose of this study was to identify the priority educational needs, barriers to adopting management practices, and assess the overall implementation program areas that had occurred so far in the Arroyo Colorado Watershed located in Cameron, Hidalgo, and Willacy Counties of Texas.

Research Objectives

The following research objectives were developed to support the purpose of this study:

1. Identify the educational needs related to water
2. Identify the barriers to incentive program adoption

3. Assess the overall agricultural implementation program

Significance of Study

Watersheds across the nation have similar issues where a primary contributor to nonpoint source pollution has been identified as agricultural production. This study will help federal, state, and local agencies prioritize educational programs for the Arroyo Colorado related to water to be delivered to agricultural producers in an effort to conserve water quantity and mitigate agricultural impacts to water quality. This study will also identify the primary barriers to the adoption of incentive programs by agricultural producers and help agencies adapt their programs to meet the needs of those producers. Finally, this study will assess the perception of agricultural producers on the implementation efforts by the Arroyo Colorado Watershed Partnership and identify which of the key areas needs additional focus. Overall, this study will provide results that will help prioritize needed implementation areas of water management in the Arroyo Colorado Watershed.

Delimitations

The goal of this study was to identify the 1) educational needs, 2) barriers to incentive program adoption, and 3) perceived program effectiveness of agricultural producers in Cameron, Hidalgo, and Willacy Counties. While this assessment will be useful in guiding future implementation efforts in the Lower Rio Grande Valley, results reflect the perceptions of only the individuals surveyed and may not be indicative of the population as a whole.

Limitations

The target population in this study was agricultural producers in Cameron, Hidalgo, and Willacy counties of Texas; however, an accessible sampling frame consisted of those who signed up for USDA-FSA programs from 2008 – 2011 and mailing list contacts from the local Texas A&M AgriLife Extension Service County Extension Agents. As a result of this, the survey web link and survey were mailed out to a random sample of individuals from this list, some of which may or may not have been active in agricultural production. Additionally, a portion of the data-collection period may conflict with the time of year that some producers are harvesting, which may have reduced response rates.

CHAPTER II

IDENTIFYING EDUCATIONAL WATER RELATED NEEDS OF AGRICULTURAL PRODUCERS IN THE LOWER RIO GRANDE VALLEY OF TEXAS

Synopsis

Agricultural producers have many interests related to water, making it difficult to prioritize which type of educational program to deliver. It is even more difficult to know if the program is relevant to their situation. In this research, the objective was to identify primary educational needs of agricultural producers in the Lower Rio Grande Valley of Texas related to water. Water quantity was found to be the highest educational need, especially as it related to upcoming irrigation water availability. Finally, some differences could be identified between demographic information, latent and manifest variables, most of which related to water quality, based on demographic differences.

Keywords

Educational Need, Water Quality, Conservation Practices, Financial Incentives, Water Quantity

Introduction

Agriculture is a common source that contributes to water quality impairments across the United States, and the Lower Rio Grande Valley of Texas is no different. Half of the land-use in this area consists of agricultural production, and as a result of this and rapid urbanization, the local water body has been identified as not meeting some state water quality standards. To address this issue, it has been the goal of a local Arroyo

Colorado Watershed Partnership to deliver educational messages and encourage the adoption of sustainable agricultural practices through incentive programs; however, it had been mentioned to partnership personnel that some messages were outdated, irrelevant, or just uninteresting. With agricultural production constantly changing as a result of new technologies, changes in environmental regulations, climate change, differences in input prices, commodity prices, and many other factors, agricultural producers are in need of new educational materials. New information is also becoming available on environmental requirements, information and technologies that will increase yields, production efficiency, and mitigation strategies for environmental impacts. The need to educate and disseminate relevant information to agricultural producers is more important than ever. Planning and conducting these educational events requires a certain amount of information regarding what new material producers are interested in, how that information should be delivered, and other factors. It is the goal of this research to identify the educational needs related to water for agricultural producers in the Lower Rio Grande Valley of Texas.

Overall Need for Education

Barrick (1989) wrote that education is focused on the philosophies and approaches to teaching and learning. In this sense, agricultural education focuses on specific topics of interest to producers and methods of learning and teaching to ensure that the program is effective. Because agricultural production continuously changes as technologies become available, educational messages continue to adapt as well. The Cooperative Extension Service, originally developed primarily to make educational

opportunities available for those who do not go to college, is the primary agency for disseminating technologies to agricultural producers (Cash, 2001). Overall, technology has improved agricultural efficiency and since World War II, the US has been one of the leaders in crop production. As a result, environmental impacts have been in question (Reganold, Papendick, & Parr, 1990). Tilman, Cassman, Matson, Naylor and Polansky (2002) wrote that agriculture contributes to the addition of nutrients to our ecosystems in a rate that may triple if we continue to use traditional production methods. Additionally, they discussed the potential use of sustainable agricultural practices that can be utilized to meet our food, fiber, and ecosystem needs. Similar to transferring other production technologies, educational programs must be developed for sustainable agricultural practices. Shepard (1999) mentions that educational programs provide information to landowners that encourage sustainable agricultural practice adoption. Education, with regard to nonpoint source pollution, is a component of most state and federal water quality programs (Ribaudo & Horan, 1999). Ribaudo and Horan also wrote that education is a popular approach for several reasons, including: 1) education is not as expensive (to the government) as cost-share programs, 2) the structure for disseminating information for the most part already exists, and 3) there is prior evidence where education is effective in gaining adoption of practices. One specific example is the study conducted by Feather and Amacher (1994), where it was determined that uncertainty regarding adoption of management practices is reduced through educational programs, and thus, adoption of practices increases.

Determining Educational Needs

Determining educational gaps and needs for agricultural producers has not been a widely studied subject, especially related to water quality or sustainable agricultural production. Bridges (2008) mentions that identifying community needs is necessary to deliver effective educational programs. One study conducted by Ford (1995) addressed this objective, primarily to determine whole farm needs by surveying small farms in West Tennessee. He concluded that their educational needs were primarily related to crop marketing, production, and soil conservation practices. Kitchen, Snyder, Frazen and Wiebold (2002) studied the educational needs of precision agriculture, partially by determining barriers to adoption of the technology. Part of the barriers were related to "insufficient and ineffective education," indicating that efforts need to be prioritized to fit producer needs. Feather and Amacher (1994) wrote that the lack of information regarding sustainable agricultural practices and misinterpretations of potential effects on profits might have resulted in the lack of adoption. They concluded that adoption of practices is highly reliant on the perceptions of agricultural producer and that changing these perceptions through education may be a viable alternative to financial incentives in encouraging the adoption of practices. In a review conducted by Christensen and Norris (1983), many agricultural producers did not make the connection between erosion, pesticides, and fertilizers and the local water quality. Additionally, producers in the study said that they needed more information about controlling pollution and additional information about conservation programs. All of these studies showed the need for prioritized educational programs.

Education and Adoption of Sustainable Agricultural Practices

Sustainable agricultural practices are designed to mitigate agricultural impacts to water quality, and many barriers exist related to the adoption of practices, a primary one being the lack of education. Nowak (1992) described two reasons for non-adoption: 1) being unable to adopt and 2) being unwilling to adopt. In the first reason, he describes that information is lacking or scarce, the availability and accessibility of supporting resources is limited, and inadequate managerial skills are limiting factors, which are directly tied to education. In his second reason, he wrote that limitation is related to conflicting information, poor applicability and relevance of information, ignorance on the part of the farmer or promoter of technology, the adoption of practices is perceived as increasing the risk of negative outcomes, and belief in traditional practices, all of which relate to education. It is important to assess the educational needs of agricultural producers to avoid these barriers. Alonge and Martin (1995) supported this by indicating that a needs assessment and analysis are important if producers are going to understand sustainable agricultural practices.

Methods

The objective of this study was to determine the priority educational needs of agricultural producers in Cameron, Hidalgo, and Willacy counties of Texas and to determine whether specific educational interests differed amongst demographics. The study population consisted of agricultural producers in Cameron, Hidalgo, and Willacy counties of Texas; however, a comprehensive list of contact information for the population was nonexistent. Because of this, contact information was retrieved from

both the USDA-FSA Farm Payment Files Information database and the mailing list from Texas A&M AgriLife County Extension Agents. They were combined into a single list, resulting in a sampling frame of 2,547. From this list, a random sample of 1,200 individuals were chosen to participate in the study by assigning each a random number, and then sorting from lowest to highest. The first 1,200 were selected to participate in the study.

Instrumentation

For this study, the same instrument was used in an electronic and hard copy format. Sixteen questions requesting information about the perceived educational needs for agricultural producers were presented in a Likert Scale with six response options of Strongly Agree (1), Agree (2), Somewhat Agree (3), Somewhat Disagree (4), Disagree (5), and Strongly Disagree (6). These questions were arranged so that the first four questions related to water quality, questions five through eight were related to conservation practices, questions nine through twelve were related to financial incentives, and questions thirteen through sixteen were related to water quantity. An optional text response was included for participants to include any other educational needs that may not have included in the questions above. Finally, demographic information was asked of participants. This included educational level, gender, ethnicity, and age.

Data Collection

Dillman's (2000) Tailored Design Method was used where individuals were notified of their participation via postcard. This postcard contained a web link to the

instrument, and potential participants were allowed one week to complete the evaluation online. After a week, a hard copy of the instrument, along with a cover letter containing an electronic link, were sent to participants. Two weeks after the hard copy evaluation was mailed, a reminder postcard was sent that also contained the web link. A final hard copy evaluation was mailed to participants two weeks after the reminder postcard that contained the web link as well. Individuals who returned the evaluation or indicated that they did not want to participate in the study, were removed from the mailing list so that they were not mailed the evaluation more than once.

Analysis

Statistical Package for Social Sciences (SPSS) Version 22 was used to conduct data analysis. Descriptive statistics were run for demographic, manifest (measurable), and latent (construct) variables. In addition, Cronbach's alpha was calculated for all sixteen manifest variables and each group of four manifest variables that made up the four latent variables. Further, factorial ANOVA was conducted treating each of the sixteen manifest variables and four latent variables as dependent variables and demographic variables as independent variables. No interaction effects are evaluated due to the utility of the results; therefore, only main effects of demographic variables were evaluated. Where statistically significant differences were identified ($p<.05$), post hoc analysis was conducted. Finally, to determine if any differences may exist between those that responded and those that did not respond, responses to the first evaluation are being compared to responses of the second evaluation (Lindner, Murphy, & Briers, 2001).

Results

The response rate achieved in this study was 24.1% (274 returned surveys of the 1,137 that were deliverable) where 11 respondents completed the survey online, 91 from the first mailing, and 58 from the second. 114 individuals returned the survey opting not to complete it leaving researchers with 160 total usable responses. Results of this survey are not representative of the population as a whole but just those that responded during this study. Table 2 contains demographic characteristics for those who returned the survey.

Table 2

Demographic Characteristics of Participants

Characteristic	n	%
Age at time of evaluation (years)		
18 - 30	2	1.3
31 - 50	20	12.5
51 - 70	83	51.9
71 and over	47	29.4
Gender		
Male	128	80.0
Female	25	15.6
Ethnicity		
American Indian or Alaska Native	1	.6
Spanish, Hispanic, Latino	58	36.3
White	91	56.9

Table 2 Continued

Characteristic	n	%
Education level		
Less than High School	9	5.6
High School Diploma	25	15.6
Some College	41	25.6
Bachelor's Degree	53	33.1
Post-Graduate Degree	25	15.6

Note. N=160

Sixteen variables were developed to assess the educational needs of agricultural producers. Table 3 contains the mean, standard deviation, and number of responses for the variables relating to the question "Please indicate your level of agreement regarding what you think are some educational needs for agricultural producers related to water." Combined, the variables resulted in a Cronbach's alpha of 0.96.

Table 3

Mean, Standard Deviation, and Number of Responses for Manifest Variables

Education Topic	M	SD	N
1. How water quality impacts your operation	1.77	.970	140
2. How agricultural production impacts water quality	1.88	.913	139

Table 3 Continued

Education Topic	M	SD	N
3. What current water quality levels are (eg. nutrients, salinity, etc.)	1.82	.859	137
4. Specific conservation practices that improve water quality	1.90	.911	139
5. How I can improve my operation by adopting conservation practices	1.94	.907	139
6. Updates on conservation practice effectiveness	1.95	.854	139
7. How to install/maintain conservation practices	1.96	.928	139
8. Fertility application methods (eg. nutrient management)	1.96	.924	139
9. Sources of financial incentives available to help pay for conservation practices	1.84	1.036	140
10. Requirements of financial incentive programs	1.99	1.007	139
11. How to apply for financial incentives	1.82	.921	136
12. Information about upcoming incentive programs	1.91	1.050	138
13. Specific conservation practices that reduce the amount of irrigation water used	1.79	.928	139
14. How much water is needed to produce various crops	1.91	.916	138

Table 3 Continued

Education Topic	M	SD	N
15. Current and new irrigation technologies	1.83	.937	139
16. How much irrigation water is available for the upcoming year	1.64	.969	140

Note. Scale: 1.00-1.49 = "strongly agree;" 1.50-2.49 = "agree;" 2.50-3.49 = "somewhat agree;" 3.50-4.49 = "somewhat disagree;" 4.50-5.49 = "disagree;" 5.50-6.49 = "strongly disagree."

To better classify the responses, variables were combined into latent variables, where manifest variables one through four were related to the construct of water quality, five through eight to conservation practices, nine through twelve to financial incentives, and thirteen through sixteen to water quantity. This allowed the researcher to determine what the highest broad priority areas were and then narrow them by manifest variable. Descriptive statistics for latent variables are displayed in Table 4. For each of the latent variables, a Cronbach's alpha was calculated and resulted in water quality – 0.87, conservation practices – 0.93, financial incentives – 0.94, and water quantity – 0.86.

Table 4

Mean, Standard Deviation, and Number of Responses for Latent Variables

Name of Variable	M	SD	N
Water Quality	1.84	.78	140

Table 4 Continued

Name of Variable	M	SD	N
Conservation Practices	1.95	.82	140
Financial Incentives	1.90	.95	140
Water Quantity	1.80	.82	140

Note. Scale: 1.00-1.49 = "strongly agree;" 1.50-2.49 = "agree;" 2.50-3.49 = "somewhat agree;" 3.50-4.49 = "somewhat disagree;" 4.50-5.49 = "disagree;" 5.50-6.49 = "strongly disagree."

Beyond general means, a factorial ANOVA was conducted using latent and manifest variables as dependent variables and demographic variables as dependent variables to determine if there were any differences between groups ($p<.05$). Some significant differences occurred within interaction effects; however, their utility is minimal. As a result, only single level main effects was analyzed. If significant differences occur, post hoc analysis was conducted.

Water Quality

Beginning with the latent variable of water quality, there were significant differences between levels of education [$F(4,130) = 6.39$, $p = .001$] ($\eta_p^2 = 0.22$, $1- \beta = 0.99$, $M=1.80$, $SD=.70$) and their responses to the water quality variables. The differences occurred between those with less than high school education ($M=1.31$, $SD=.70$) and those with a high school diploma ($M=2.15$, $SD=.87$). Next, a factorial ANOVA was conducted where manifest variables were used. A difference was found in

"1. How water quality impacts your operation" based on education level [F (4,130) = 6.23, p = .001] (η_p^2 = 0.22, 1- β = 0.99, M=1.74, SD=.91) where less than high school (M=1.25, SD=.71) and Bachelors degree (M=1.53, SD=.83) differ from those with a high school diploma (M=2.29, SD=1.15). Next, participants with different education levels differed in regard to their response to the question "2. How agricultural production impacts water quality" [F(4,129) = 3.52, p = .01] (η_p^2 = 0.13, 1- β = 0.85, M=1.84, SD=.85) where respondents with less than high school (M=1.25, SD=.71) agreed more than those with a high school diploma (M=2.10, SD=.94). Other education levels were not significantly different from each other. Respondents also differed in their response to "3. What current water quality levels are (eg. nutrients, salinity, etc.)" by education level [F (4,128) = 3.76, p = .01] (η_p^2 = 0.14, 1- β = 0.87, M=1.76, SD=.78) where less than high school (M=1.25, SD=.46) agreed more than respondents with high school diploma (M=2.05, SD=.92). Finally, statistically significant differences could be identified between responses to "4. Specific conservation practices that improve water quality" based on gender [F(1,129) = 3.98, p = .05] (M η_p^2 = 0.04, 1- β = 0.51, =1.87, SD=.85) where females (M=1.61, SD=1.09) agreed more than males (M=1.91, SD=.80) on the variable. There was no difference identified between early and late responders for any water quality variables (1. How water quality impacts your operation (p = 0.40), 2. How agricultural production impacts water quality (p = 0.38), 3. What current water quality levels are (eg. nutrients, salinity, etc.)(p = 0.22), and 4. Specific conservation practices that improve water quality (p = 0.19)) indicating that non-responders do not differ from responders.

Conservation Practices

No significant differences were identified between latent and manifest conservation practice variables based on levels of demographic variables. There was no difference identified between early and late responders for any conservation practice variables (5. How I can improve my operation by adopting conservation practices ($p = 0.31$), 6. Updates on conservation practice effectiveness ($p = 0.41$), 7. How to install/maintain conservation practices ($p = 0.31$), and 8. Fertility application methods (e.g. nutrient management)($p = 0.36$)) indicating that there is no difference between responders and non-responders.

Financial Incentives

The latent variable of financial incentives was then used, and a significant difference was found in gender responses [$F(1,129) = 3.84$, $p = .05$] ($\eta_p^2 = 0.04$, $1- \beta = 0.49$, $M=1.86$, $SD=.88$) where males ($M=1.92$, $SD=.90$) differed from females ($M=1.47$, $SD=.66$) in their responses. Of the manifest variables, a significant difference could be located in "10. Requirements of financial incentive programs" based on gender [$F(1,128) = 6.80$, $p = .01$] ($\eta_p^2 = 0.07$, $1- \beta = 0.73$, $M=1.95$, $SD=.95$) where females ($M=1.39$, $SD=.61$) agreed more that education was needed than did males ($M=2.04$, $SD=.97$). There was no difference identified between early and late responders for any financial incentive variables (9. Sources of financial incentives available to help pay for conservation practices ($p = 0.22$), 10. Requirements of financial incentive programs (0.22), 11. How to apply for financial incentives ($p = 0.33$), and 12. Information about

upcoming incentive programs (p = 0.34)) indicating that there is no difference between responders and non-responders.

Water Quantity

No significant differences were identified in latent and manifest water quantity variables based on demographic variables. There was no difference identified between early and late responders for any water quantity variables (13. Specific conservation practices that reduce the amount of irrigation water used (p = 0.41), 14. How much water is needed to produce various crops (p = 0.25), 15. Current and new irrigation technologies (p = .22), and 16. How much irrigation water is available for the upcoming year (p = .46)) indicating that there is no difference between responders and non-responders.

Discussion and Conclusions

Delivering water related programs is becoming more common as we face new challenges, but delivering programs that agricultural producers are interested in is also important. In the Lower Rio Grande Valley of Texas, a highly irrigated area of the state, agricultural producers are more interested in water quantity than other educational areas related to water. Specifically, they wanted to know how much water is available for the upcoming year and what practices can be used to reduce the amount of water used. The following manifest variables are ordered from highest to lowest priority:

- 16. How much irrigation water is available for the upcoming year
- 13. Specific conservation practices that reduce the amount of irrigation water used

- 15. Current and new irrigation technologies
- 14. How much water is needed to produce various crops

Second, water quality programs should be delivered to agricultural producers related to how water quality impacts their operation and what current water quality levels are. These top two responses are tied to irrigation water; therefore, when delivering water quantity programs, water quality components should be delivered as well. Water quality related variables were the second highest overall educational needs. Specifically, the following specific educational topics that make up the latent water quality variable are ordered from highest to lowest priority:

- 1. How water quality impacts your operation
- 3. What current water quality levels are (eg. nutrients, salinity, etc.)
- 2. How agricultural production impacts water quality
- 4. Specific conservation practices that improve water quality

Differences could be identified within water quality latent and manifest variables. Those that had less than high school were more interested in water quality than those with a high school diploma. Respondents with less than high school diploma and Bachelors degree agree more with the question of "1. How water quality impacts your operation" than respondents with a high school diploma. Respondents with less than high school agree more with the question of "2. How agricultural production impacts water quality" than respondents with a high school diploma. Respondents with less than high school agree more with the question "3. What current water quality levels are (eg. nutrients, salinity, etc.)" than respondents with a high school diploma. Female

respondents agreed more than males on the need for education on the topic "4. Specific conservation practices that improve water quality."

The variables that respondents agreed with the third most were related to financial incentives. Looking at the means of each of the financial incentive manifest variables, programs should be delivered regarding how to apply for financial incentive and sources of incentives to help pay for conservation practices. Incentive programs that producers are interested in will most likely assist in paying for practices to reduce water quantity and maintain soil health. The following manifest variables are ordered from highest to lowest priority:

- 11. How to apply for financial incentives
- 9. Sources of financial incentives available to help pay for conservation practices
- 12. Information about upcoming incentive programs
- 10. Requirements of financial incentive programs

Differences could be identified between latent and manifest financial incentive variables where females agreed more to financial incentive variables than did males, and females agreed more than males to "10. Requirements of financial incentive programs."

Respondents agreed less with educational needs related to conservation programs; however, they want to know how they can improve their operation by adopting conservation practices and how effective those conservation practices are. Information in both of these can help persuade producers into adopting practices. The following manifest variables are ordered from highest to lowest priority:

- 5. How I can improve my operation by adopting conservation practices

- 6. Updates on conservation practice effectiveness
- 7. How to install/maintain conservation practices
- 8. Fertility application methods (e.g. nutrient management)

Finally, there was no difference between early and later responders in their response to any water quality variable, indicating that there is no difference between responders and non-responders.

Recommendations

Recommendations from this research consist of developing an irrigation training program that touches primarily on water quantity technologies, methods to reduce irrigation water used, and what water is currently available for irrigation, but should also consist of what levels of water quality irrigation water is at, how that irrigation water will impact the land, and methods to mitigate bad water quality. Practices related to both water quality and quantity should be promoted through financial incentive programs and trainings on how to participate in those programs. Each of these programs should touch on conservation practices that can be used.

Future research should consist of measuring educational needs at the various events that are hosted by educators to ensure that programs are touching on subjects that agricultural producers need in order to be profitable and environmentally friendly. Also, an overall assessment should be conducted again prior to the next update of the watershed protection plan so that changing demographic needs can be captured. Finally, future assessments should be conducted in other areas of the state to identify similarities,

allowing for the opportunity to develop a statewide program, and differences where programs should only be delivered at the local level.

CHAPTER III

DETERMINING BARRIERS TO ADOPTING SUSTAINABLE AGRICULTURAL PRACTICES BY AGRICULTURAL PRODUCERS IN THE LOWER RIO GRANDE VALLEY OF TEXAS

Synopsis

As in any watershed, agricultural producers in the Arroyo Colorado Watershed who are located in the Lower Rio Grande Valley of Texas must overcome barriers to adopting sustainable agricultural practices; however, knowing what the primary barriers are and who faces them is a challenge. This paper seeks to identify the primary barriers to adopting practices by producers, the broad categories that rank the highest, and where the differences in demographics lie. Results showed that most of the barriers fell within the economic barriers category, with the primary barrier being the initial cost of installing, followed by low incentive levels and the lack of available cost share funds. When it came to responses to latent and manifest barriers, most of the differences in demographics occurred between levels of age and levels of education. The only difference between demographics and adopting practices could be identified in ethnicity. Finally, there were no significant differences identified between different barriers and their impact on whether practices were adopted or not.

Keywords

Sustainable Agricultural Practices, Barriers, Adoption, Water Quality

Introduction

The Arroyo Colorado watershed is located in the Lower Rio Grande Valley of South Texas, just north of the Rio Grande River. The watershed covers about half of the landmass in the Valley, and the Arroyo Colorado River is the primary source of freshwater to the Lower Laguna Madre. Flow in the Arroyo Colorado is sustained by municipal discharges and agricultural irrigation tailwater, both of which carry nutrients, sediment and bacteria, and has resulted in the water body being listed as not meeting state standards for dissolved oxygen and bacteria. In an effort to mitigate these impairments, the Arroyo Colorado Watershed Partnership was created that consisted of various workgroups, with one of them focused specifically on Agricultural Issues. Each of the workgroups contributed recommendations on how their interest can help reduce pollution going into the Arroyo Colorado, and the Agricultural Issues workgroup came up with a goal of adopting 10,000 acres under sustainable agricultural practices each year for nine years. To accomplish this goal, the workgroup recommended four types of assistance (education, cost-share assistance, technical assistance, and monitoring and assessment) needed to get agricultural producers to adopt sustainable agricultural practices; however, fewer practices have been adopted than anticipated. Through meetings with agricultural producers, a variety of barriers to adopting practices have been mentioned, but there has been some inconsistency in determining the primary barriers.

Sustainable agricultural practices have been developed, and through scientific testing, have proven to be an effective way in reducing nonpoint source pollution impacts to water bodies.

Assistance in paying for these practices is often available through an incentive program that will pay for a portion (cost-share) of the installation costs that agricultural producers incur; however, it was previously mentioned that many producers do not take advantage of the available cost-share money. This has brought forth the question of what the barriers to adopting practices are.

Here, we outline some challenges and barriers of watershed management for agriculture and efforts to understand barriers to the adoption of sustainable agricultural practices.

Barriers to Adopting

As the world's population continues to grow, estimated at 9.7 billion by 2050 (United Nations, 2013), the need to produce more food continues to grow. Tilman (1999) wrote that production of food over the last 35 years has been a result of the application of additional nutrients and will continue to increase. This application has brought up issues related to both surface water and groundwater quality contamination (Supalla, Selley, & Bredeweg, 1995). In an effort to mitigate these issues, sustainable agricultural practices are implemented, sometimes through incentive programs; however, not all agricultural producers adopt these practices. Multiple studies have been completed to understand the barriers to sustainable agricultural practice adoption. Reimer, Weinkauf, and Prokopy (2011) mentioned that there is a large literature base

related to studying the voluntary adoption of practices, but results have been inconsistent. There are many factors that contribute to barriers to the adoption of practices. Rodriguez, Molnar, Fazio, Snyder and Lowe (2008) conducted a study designed to understand barriers to sustainable agricultural practices and determined that even though technical assistance was adequately provided, producers rarely adopted practices. This study also indicated that economic and education/information issues are among the most common themes that arose. In 1996, Drost, Long, Wilson, Miller and Campbell, wrote that the majority of respondents noted that economic factors, availability of information, and the constraints of federal farm programs were the primary barriers to adoption. Lamba, Filson, and Adekunle (2008) studied a population of famers in southern Ontario and determined that their primary barriers were related to farm and personal characteristics. In a USDA-NRCS (2003) study to determine what barriers influence the adoption of nutrient management practices, results were such that perceptions about governmental programs by producers were not favorable, keeping them from adopting practices. Knowler and Bradshaw (2007) reviewed previous research about farmers' reasons for adopting practices and wrote that "financial viability is an important consideration… but it is tempting to conclude that other non-financial factors may be constraining further adoption." Contradictory to this, Rodriguez et al. (2008) reported that the highest obstacle was related to economics, followed by education and information, resistance to change, social considerations, infrastructure, landless, and personal characteristics. In all, it is difficult to pinpoint specific barriers to sustainable agricultural adoption, although many of them can be categorized. In a review

focused on 25 years of literature related to the adoption of practices, Prokopy, Floress, Klotthor-Weinkauf, and Baumgart-Getz (2008) found that "results are clearly inconclusive about what factors consistently determine BMP adoption." This determination presents a challenge for agencies as they implement programs in watersheds.

Determining what factors affect the adoption of sustainable agricultural practices has thus far appeared to be a need that should be studied at the local level. Several studies have attempted to do so, finding that some overlap exists; however, some factors are unique to each study. Prokopy et al. (2008) found that characteristics such as "education levels, capital, income, farm size, access to information, positive environmental attitudes, environmental awareness, and utilization of social networks emerge as some of the variables that are more often positively, rather than negatively, associate with adoption rates." Reimer et al. (2011) indicated that adoption is related to high relative advantages such as the reduction of inputs, on-farm benefits, and time savings. He also wrote that lower adoption levels are related to low levels of relative advantage. Greiner, Patterson and Miller (2009) mention that "strong conservation and lifestyle motivation translates to intrinsic motivation for adoption of conservation practices, while option values prevent strongly economically/financially motivated farmers from adopting in the absence of external incentives." In a study by Gillespie, Kim and Paudel (2007), the two primary reasons of why producers don't adopt management practices were related to unfamiliarity and non-applicability. Baumgart-Getz, Prokopy and Floress (2012) summarized 31 social factors that had been assessed

over the last 25 years, and reported that environmental awareness and attitudes are positive influences on the adoption of management practices. Other motivations, as assessed by Ryan, Erickson, and De Young (2003), were more related to the producer's tie to the land rather than economic factors. Various methods were used in the assessments, most of which came in the form of mailed surveys and focus groups. Overall, research efforts have attempted to determine what motivating factors have increased the adoption of sustainable agricultural practices; however, studies of various populations indicate that there are a variety of motivating factors and that elements should be assessed on a case-by-case basis. The purpose of this study was to determine the priority barriers of adopting sustainable agricultural practices for agricultural producers in the Lower Rio Grande Valley of Texas. Specifically, the study focused on achieving the following objectives:

1. Identify specific, priority barriers to adopting sustainable agricultural practices
2. Classify overall broad categories of barriers to adopting sustainable agricultural practices
3. Identify differences in manifest (measurable) and latent (construct) variables amongst demographics
4. Identify differences in demographics on whether they have adopted or not
5. Identify differences in manifest and latent variables between adopters and non-adopters of sustainable agricultural practices

Methods

Participants in this study were selected from the USDA-FSA Farm Payment Files Information database and local Texas A&M AgriLife County Extension Agent mailing lists in an effort to target the population of agricultural producers in Cameron, Hidalgo, and Willacy counties. A sampling frame of 2,547 producers were compiled into a database and assigned a random number. Random numbers were sorted from lowest to highest and the first 1,200 individuals were selected to participate in the study; however, only 1,137 contained deliverable addresses.

Researchers developed a data collection instrument that consisted of eighteen, six point (Strongly Agree (1), Agree (2), Somewhat Agree (3), Somewhat Disagree (4), Disagree (5), Strongly Disagree (6)) Likert scale questions. Questions were developed by generally following those that Rodriguez et al. (2008) had outlined in their study. Also, participants were asked whether they had adopted practices to their operation or not, followed by demographic questions (age, ethnicity, gender, education level). To collect data, Dillman's (2000) Tailored Design Method was used where a pre-notice postcard was mailed, one week later a cover letter and survey, two weeks later a reminder postcard, then two weeks later a final cover letter and survey. Of the 1,137 deliverable addresses, 274 participants opted to return the survey (11 completing online, 91 completing the first mailing, 58 completing the second mailing, and 114 returning the survey without completing), resulting in 160 usable responses but a 24.1% response rate. It should be mentioned that responses to this instrument are perceptions of respondents and not representative of the population as a whole.

To conduct data analysis, Statistical Package for Social Sciences (SPSS) Version 22 was used. Analysis began with calculating descriptive statistics (mean, standard deviation, number of responses) of manifest variables (measurable variables) to determine what the primary barriers to adopting practices were. Secondly, manifest variables were combined into latent variables (constructs) to determine what broad categories the barriers fell in to. A factorial ANOVA was conducted to identify significant differences within demographics for both latent and manifest variables of barriers to management practice adoption. Also, a factorial ANOVA was conducted using demographic variables as independent variables, and the questions of whether producers had adopted or not as dependent variables to determine if there were main effect and interaction effects of demographics on the decision to adopt. A factorial ANOVA was also used to determine if latent and manifest variables differed amongst those who responded as having adopted practices or not. A factorial ANOVA was also conducted to determine if there was a difference between participants who had adopted practices in participants who had not adopted practices and their response to latent and manifest variables. All tests for statistical significance were set at an *a priori* alpha of .05. Finally, to determine if any differences may exist between those that responded and those that did not respond, responses to the first evaluation are being compared to responses of the second evaluation (Lindner, Murphy, & Briers, 2001).

Results

Objective 1

Eighteen manifest variables were measured (table 5) in an attempt to identify the priority barriers to adopting sustainable agricultural practices by asking participants to "Please indicate your level of agreement regarding the reasons you HAVE NOT adopted conservation practices through incentive programs." Cronbach's alpha was calculated with all manifest variables, called barriers to adoption, and resulted in an alpha of 0.91. Table 5 contains descriptive statistics (mean, standard deviation, and number of responses) for each manifest variable and participants' response to whether they had adopted or not. As seen, the initial cost of installing (M=2.05) as the barrier was agreed with the most, followed by incentive (cost-share) levels being too low (M=2.17) and the lack of available cost-share funds. (M=2.20). The first two barriers indicate that installing costs are an expense that producers are less willing to incur, but low cost-share levels also act as a barrier to adopting practices. A common message from producers in the area was that cost-share funds were unavailable, and a high agreement to the lack of cost-share funds supports this. Fourth, maintenance costs (M=2.22) act as a barrier to adopting practices. Cost-share programs assist in paying for the initial cost of installing; however, the maintenance cost is something that producers are sometimes not willing to incur. Next, both the eligibility of the incentive program (M=2.28) and lack of information about conservation practices effectiveness (M=2.28) act as barriers because some incentive programs provide one time only funds, and the lack of information about whether the conservation practice actually works can reduce the likelihood of adoption,

respectively. Finally, the variable that respondents agreed with seventh most was that producers were uncertain if practices would increase or decrease profit (M=2.29). With the inclusion of the last variable, all of the economic barriers had been agreed with amongst the top half of all the variables. This indicates that economics, overall, may be the largest barrier to adopting sustainable agricultural practices. Objective two contains the results of that analysis and differences in means between respondents who have adopted practices and those that have not.

It should be mentioned that within the manifest variables, some statistically significant differences could be found between those that have and those that have not adopted practices and their response to manifest variables. Specifically, a difference could be found within the variable "4. Uncertain if practices will increase or decrease profit" [F (1, 108) = 4.05, p = .05] (η_p^2 = 0.04, 1- β = 0.51) where respondents that have adopted practices (M=2.42, SD=1.15) agreed less that the variable was a barrier than those that have not adopted practices (M=2.02, SD=.93). Similarly, those that have adopted practices (M=2.88, SD=1.22) significantly differed [F(1,106) = 5.791, p=.02] (η_p^2 = 0.05, 1- β = 0.66) from those that have not adopted practices (M=2.37, SD=.95) in their response to "7. Land does not meet the requirements of the program." Thirdly, responses to the variable "14. Lack of labor to implement conservation practices" differed significantly [F(1,108) = 4.734, p=.03] (η_p^2 = 0.04, 1- β = 0.58) where those that have adopted practices (M=2.68, SD=1.22) agreed less about the variable being a barrier than those that have not adopted practices (M=2.20, SD=2.08). Finally, those that have adopted practices (M=3.13, SD=1.39) agree less than those that have not adopted

practices (M=2.31, SD=1.13) to the variable of "15. Conservation practices are outside of my methods of operating" [$F(1,108) = 11.15$, $p = .001$] ($\eta_p^2 = 0.095$, $1- \beta = 0.91$) being a barrier.

Table 5

Descriptive Statistics for Manifest Barriers to Adoption by Adoption Category

Variable	Adopted Y/N	M	SD	N
1. Initial cost of installing	Yes	2.04	1.19	57
	No	2.00	1.14	53
	Total	2.02	1.17	110
2. Maintenance costs	Yes	2.38	1.27	58
	No	2.02	1.06	52
	Total	2.21	1.18	110
3. Incentive (cost-share) levels are too low	Yes	2.22	1.24	58
	No	2.00	0.97	52
	Total	2.12	1.12	110
4. Uncertain if practices will increase or decrease profit	Yes	2.42	1.15	57
	No	2.02	0.93	53
	Total	2.23	1.06	110
5. Eligibility of a program	Yes	2.32	1.18	56
	No	2.13	0.99	52
	Total	2.23	1.09	108
6. Lack of available cost-share funds	Yes	2.09	1.08	58
	No	2.22	0.97	51
	Total	2.15	1.03	109
7. Land does not meet the requirements of the program	Yes	2.88	1.22	56
	No	2.37	0.95	52
	Total	2.63	1.12	108

Table 5 Continued

Variable	Adopted Y/N	M	SD	N
8. Terms of the contract	Yes	2.71	1.29	56
	No	2.44	1.07	52
	Total	2.58	1.19	108
9. Did not know about incentive programs	Yes	2.36	1.33	61
	No	2.35	1.20	52
	Total	2.35	1.27	113
10. Lack of information about conservation practice effectiveness	Yes	2.36	1.21	56
	No	2.15	1.04	52
	Total	2.26	1.13	108
11. Lack of opportunities to see practices at demonstrations	Yes	2.40	1.20	55
	No	2.15	1.00	52
	Total	2.28	1.11	107
12. Lack of educational opportunities about conservation practices	Yes	2.39	1.23	54
	No	2.22	0.99	51
	Total	2.30	1.12	105
13. Lack of time to implement/maintain conservation practices	Yes	2.71	1.25	56
	No	2.37	1.20	51
	Total	2.55	1.23	107
14. Lack of labor to implement conservation practices	Yes	2.68	1.22	59
	No	2.20	1.08	51
	Total	2.45	1.18	110
15. Conservation practices are outside of my methods of operating	Yes	3.13	1.39	56
	No	2.31	1.13	52
	Total	2.73	1.33	108

Table 5 Continued

Variable	Adopted Y/N	M	SD	N
16. Belief that adopting practices would really make a difference in water quantity and/or water quality	Yes	2.72	1.49	57
	No	2.43	1.20	51
	Total	2.58	1.36	108
17. Operation size is too large to implement practices	Yes	3.95	1.41	56
	No	3.71	1.35	51
	Total	3.83	1.38	107
18. Do not want to be tied to a government program	Yes	2.95	1.62	61
	No	2.79	1.50	53
	Total	2.88	1.56	114

Note. Scale: 1.00-1.49 = "strongly agree;" 1.50-2.49 = "agree;" 2.50-3.49 = "somewhat agree;" 3.50-4.49 = "somewhat disagree;" 4.50-5.49 = "disagree;" 5.50-6.49 = "strongly disagree."

Objective 2

Manifest variables were combined into latent variables to identify broad barriers to adopting sustainable agricultural practices. Cronbach's alpha for latent variables resulted in a 0.83 for economics, 0.79 for programmatic, 0.87 for information/ awareness, and 0.81 for producer/operation manifest variables. Table 6 below contains descriptive statistics for latent variables where economic barriers (M=2.16) were agreed with the most, followed by information/awareness barriers (M=2.33), programmatic barriers (M=2.45), and producer/operation barriers (M=2.72).

Statistically significant differences between several latent variables could be identified, beginning with a difference between Economic and Programmatic variables

[F(1,114) = 18.20, p = .001] (η_p^2 = 0.14, 1- β = 0.99) where respondents agreed more with Economic barriers than Programmatic barriers. Next, participants were significantly more likely to respond to Economic barriers than Information/Awareness barriers [F(1, 113) = 3.90, p = .05] (η_p^2 .03, 1- β .50) or Producer/Operation barriers [F(1,113) = 38.34, p = .001] (η_p^2 = .25, 1- β = 1.00). A statistically significant difference was also identified between the Programmatic and Producer/Operation barriers [F(1,111) = 13.40, p = .001] (η_p^2 = .11, 1- β = .95) and between Information/Awareness and Producer/Operation barriers [F(1,116) = 26.99, p = .001] (η_p^2 = .19, 1-β = .99).

Table 6

Latent Barriers to Adoption Descriptive Statistics

	M	SD	N
Economic	2.16	0.95	118
Programmatic	2.45	0.95	116
Information/Awareness	2.33	1.07	121
Producer/Operation	2.72	1.01	122

Note. Scale: 1.00-1.49 = "strongly agree;" 1.50-2.49 = "agree;" 2.50-3.49 = "somewhat agree;" 3.50-4.49 = "somewhat disagree;" 4.50-5.49 = "disagree;" 5.50-6.49 = "strongly disagree."

Objective 3

Objective 3 consisted of using the demographic main effects of a factorial ANOVA, not including interaction effects, to identify where differences occurred. The following results are divided into each of the four different latent variables where

differences in latent and manifest variables are identified. Table 7 contains demographic variables of respondents.

Table 7

Demographic Characteristics of Participants

Characteristic	n	%
Age at time of evaluation (years)		
18 - 30	2	1.3
31 - 50	20	12.5
51 - 70	83	51.9
71 and over	47	29.4
Gender		
Male	128	80.0
Female	25	15.6
Ethnicity		
American Indian or Alaska Native	1	.6
Spanish, Hispanic, Latino	58	36.3
White	91	56.9
Education level		
Less than High School	9	5.6
High School Diploma	25	15.6
Some College	41	25.6
Bachelor's Degree	53	33.1
Post-Graduate Degree	25	15.6

Note. N=160

Economic. Within the latent barrier variable of economics, a significant difference was found between levels of age [F(3,109) =4.59, p = .005] (η_p^2 = 0.16, 1- β = 0.87, M=2.16, SD=.96) where those who were 18-30 (M=1.50, SD=.35) and 71 and over (M=1.84,SD=.60) differed from those who responded between ages 31-50 (M=2.35, SD=.99) and 51-70 (M=2.28, SD=1.06) indicating that respondents between 31-70 agreed less with economic barriers than those who were 18 -30 and 71 and over. Within manifest variables, a significant difference was identified between the variable "1. Initial cost of installing" and age [F(3,106) = 4.70, p=.005] (η_p^2 = 0.16, 1- β = 0.88 M=2.04,SD=1.20) where respondents who chose 18-30 (M=1.00, SD=.00) and 71 and over (M=1.64, SD=.73) were significantly different than those who chose 51-70 (M=2.25, SD=1.35). Respondents who chose 31-50 (M=2.06, SD=1.11) were not different from either group. Next, a significant difference was found between levels of education and the manifest variable "3. Incentive (cost-share) levels are too low" [F(4,106) = 3.23, p = .02] (η_p^2 = 0.15, 1- β = 0.81, M=2.17, SD=1.21) where respondents with less than high school (M=1.38, SD=.74) agreed more than respondents with some college (M=2.53, SD=1.43). Respondents with high school diploma (M=1.90, SD=.83), post-graduate degree (M=2.20, SD=1.33), and bachelor's degree (M=2.21, SD=1.16) did not differ from the two groups previously mentioned. Finally, a significant difference occurred between the variable "4. Uncertain if practices will increase or decrease profit" and education [F(4,107) = 3.72, p = .008] (η_p^2 = 0.17, 1- β = 0.87, M=2.28, SD=1.13) where those with less than high school (M=1.5, SD=.76) differed from those with some college (M=2.52, SD=1.31). Respondents with a high school diploma (M=2.05,

SD=.81), bachelor's degree (M=2.32, SD=1.09), and a post-graduate degree (M=2.4, SD=1.31) were not significantly different from the other two groups.

There was no difference identified between early and late responders for the economic variables of "1. Initial cost of installing" ($p = 0.38$), "2. Maintenance costs" ($p = 0.10$), "3. Incentive (cost-share) levels are too low" ($p = 0.26$), indicating that responders were not different than non- responders. Contradictory, early responders did significantly differ in their response to "4. Uncertain if practices will increase or decrease profit" ($p = 0.02$), indicating that responders could be considered different than non-responders.

Programmatic. The latent variable of programmatic barriers was compared based on levels of demographic variables, and the only significant difference could be found within levels of age [$F(3,107) = 4.80$, $p = .004$] ($\eta_p^2 = 0.17$, $1- \beta = 0.89$, M=2.43, SD=.97) where post hoc analysis indicated that respondents 71 and over (M=2.04, SD=.98) and 51-70 (M=2.44, SD=.98) were significantly different than respondents 31-50 (M=2.99, SD=1.10). Respondents 18-30 (M=2.50, SD=.35) were not significantly different than any of the groups. No statically significant differences existed between demographics and any manifest programmatic variables.

There was no difference identified between early and late responders for the programmatic variables of "5. Eligibility of the program" ($p = 0.08$), "6. Lack of available cost-share funds" ($p = 0.24$), "7. Land does not meet the requirements of the program" ($p = 0.08$), and "8. Terms of the contract" ($p = 0.08$) indicating that responders were no different than non-responders.

Information/Awareness. No statistically significant difference existed between the information/awareness latent variable and levels of demographic variables. Similarly, there were no significant differences between levels of demographics and any information/awareness manifest variables.

There was no difference identified between early and late responders for the information/awareness variables of "9. Did not know about incentive programs" ($p = 0.55$), "10. Lack of information about conservation practice effectiveness" ($p = 0.96$), "11. Lack of opportunities to see practices at demonstrations" ($p = 0.46$), and "12. Lack of educational opportunities about conservation practices" ($p = 0.79$), indicating that those that responded were not different than those that did not respond.

Producer/Operation. No statistically significant differences existed between the producer/operation latent variable and levels of demographic variables. Within manifest variables, a statistically significant difference was found between "13. Lack of time to implement/maintain conservation practices" and levels of age [$F(3,104) = 5.46$, $p = .002$] ($M=2.51$, $SD=1.24$ $\eta_p^2 = 0.19$, $1- \beta = 0.93$,) where respondents 18-30 ($M=1.00$, $SD=0.00$) agreed more than those between 51-70 ($M=2.72$, $SD=1.33$). Respondents 71 and over ($M=2.23$, $SD=.86$) and 31-50 ($M=2.29$, $SD=1.26$) were not significantly different than either of the groups above. Within the manifest variable "16. Belief that adopting practices would really make a difference in water quantity and/or water quality," a significant difference was identified between levels of Ethnicity [$F(1,105) = 3.99$, $p = .05$] ($\eta_p^2 = 0.06$, $1- \beta = 0.50$, $M=2.53$, $SD=1.36$) where Spanish, Hispanic, Latino agreed more with the variable ($M=2.34$, $SD=1.27$) than those that responded as

white (M=2.75, SD=1.45). No other statistically significant differences existed within demographic variables and manifest variables.

There was no difference identified between early and late responders for the producer/operation variables of "13. Lack of time to implement/maintain conservation practices" ($p = 0.72$), "14. Lack of labor to implement conservation practices" ($p = 0.95$), "15. Conservation practices are outside of my method of operating" ($p = 0.80$), "16. Belief that adopting practices would really make a difference in water quantity and/or quality" ($p = 0.89$), "17. Operation size is too large to implement practices ($p = 0.56$), and "18. Do not want to be tied to a government program" ($p = 0.43$) indicating that respondents were not different than non-respondents.

Objective 4

A factorial ANOVA was conducted to determine if there were differences between levels of demographics and participants response to having adopted practices. A significant difference was found in the main effect of ethnicity [$F(1,123) = 6.12$, $p=.02$] ($\eta_p^2 = 0.07$, $1- \beta = 0.69$, M=1.43, SD=50) where less Spanish, Hispanic, Latino (M=1.65, SD=.48) respondents have adopted practices than White (M=1.29, SD=.46) respondents. Table 8 contains the number of respondents and associated percentage for the ethnic groups that have and have not adopted practices. Of those that responded as having adopted practices, 17 (23.9%) responded as being Spanish, Hispanic, Latino and 54 (76.1%) responded as being White. Also, of those that did not adopt practices, 32 (59.3%) of the respondents were Spanish, Hispanic, Latino while 22 (40.7%) responded as being White. Within ethic groups, 49 respondents indicated they were Spanish,

Hispanic, Latino and 34.7% (17) had adopted practices while 65.3% (32) of this demographic had not. Finally, 76 respondents indicated they were White and 71% (54) of this demographic had adopted practices while 40.7% (22) had not.

Table 8

Number of Participants Who Have Adopted and Not Adopted Sustainable Agricultural Practices by Ethnicity

Adopted Practices	Yes			No			Total	
Ethnicity	n	%	% of Ethnic Group	n	%	% of Ethnic Group	N	Total % of Ethnic Group
Spanish, Hispanic, Latino	17	23.9	34.7	32	59.3	65.3	49	39.2
White	54	76.1	71.1	22	40.7	28.9	76	60.8
Total	71	56.8		54	43.2		125	100

Note. N=125

Objective 5

Of the respondents, 71 (56.8%) indicated that they had adopted sustainable agricultural practices to their operation and 54 (43.2%) indicated that they had not. Further, there were no statistically significant differences between any latent or manifest barrier variables based on whether respondents had adopted or not.

Discussion and Conclusions

Objective 1

There will always be barriers to implementing sustainable agricultural practices, and it is no surprise that the initial cost of installing practices was the largest barrier to adoption. Ways to alleviate this would be to increase the levels of cost-share; however, producers indicated as the second highest barrier that cost-share levels were too low. This goes along with the third highest barrier of the lack of cost-share funds. Also related to costs are maintenance costs, which ranked as the fourth highest barrier. For the purposes of this study, the initial cost of installing and maintenance costs were related to economic barriers and incentive levels being too low, and the lack of available cost-share funds were both related to programmatic barriers; however, they are all associated with economics, which supports respondents primary reason for non-adoption in the Lower Rio Grande Valley.

The fifth barrier to adopting was that producers are uncertain if practices would increase or decrease profit, followed by eligibility of a program. The first barrier was treated as an information and awareness barrier, while eligibility of the program was treated as a programmatic variable; however, it could also be related to a lack of information available. The seventh barrier was a lack of information about conservation practice effectiveness, eighth was the lack of opportunities to see practices at demonstrations, ninth was the lack of educational opportunities about conservation practices, and the tenth barrier was that producers did not know about the program. The

following list contains all manifest variables that respondents agreed with in order from most to least:

- 1. Initial cost of installing
- 3. Incentive (cost-share) levels are too low
- 6. Lack of available cost-share funds
- 2. Maintenance costs
- 4. Uncertain if practices will increase or decrease profit
- 5. Eligibility of a program
- 10. Lack of information about conservation practice effectiveness
- 11. Lack of opportunities to see practices at demonstrations
- 12. Lack of educational opportunities about conservation practices
- 9. Did not know about incentive programs
- 14. Lack of labor to implement conservation practices
- 13. Lack of time to implement/maintain conservation practices
- 8. Terms of the contract
- 16. Belief that adopting practices would really make a difference in water quantity and/or water quality
- 7. Land does not meet the requirements of the program
- 15. Conservation practices are outside of my methods of operating
- 18. Do not want to be tied to a government program
- 17. Operation size is too large to implement practices

Some statistically significant differences existed between respondents that have adopted practices and those that have not. Those that have not adopted practices agreed more that the following variables were barriers to adopting practices.

- 4. Uncertain if practices will increase or decrease profit
- 7. Land does not meet the requirements of the program
- 14. Lack of labor to implement conservation practices
- 15. Conservation practices are outside of my methods of operating

Objective 2

Latent variables were developed from manifest variables to provide broad areas of barriers to adopting sustainable agricultural practices. Economic barriers were the largest barrier, followed by information/awareness, programmatic, and producer/operation.

Objective 3

Statistically significant differences could be identified within levels of demographic variables based on their responses to manifest variables. The following sections discuss what occurred in each latent variable and respective manifest variables.

Economic. Respondents agreed, overall, that economics was the largest barrier to adopting sustainable agricultural practices of all the latent variables. The following manifest variables that make up the latent variable are ordered from highest to lowest priority: 1. Initial cost of installation, 3. Incentive (cost-share) levels are too low, 2. Maintenance costs, and 4. Uncertain if practices will increase or decrease profit. Overall, respondents between 31-70 agreed less with economic barriers than those who were 18 -

30 and 71 and over. Participants who were 18-30 and 71 and over agreed more that the initial cost of installing was a barrier than did respondents between 51-70. Participants between 31-50 were not different than either group. Respondents with less than high school education agreed more that incentive (cost-share) levels were too low than did respondents with some college. Those with a high school diploma, bachelor's degree, or post-graduate degree did not differ from either group. Finally, respondents to the variable "4. Uncertain if practices will increase or decrease profit" with less than high school agreed more than those with some college. The other education levels were not different from either group. One variable, "4. Uncertain if practices will increase or decrease profit" differed between early and late responders, indicating that responders were different than non-responders. There were no other differences between early and late responders and their response to the first three variables, resulting in the conclusion that responders and non-responders to those variables were similar.

Information/Awareness. The information/awareness latent variable was the next highest barrier to adopting sustainable agricultural practices. Of that latent variable, the following manifest variables are listed in order from highest to lowest agreement: 10. Lack of information about conservation practice effectiveness, 11. Lack of opportunities to see practices at demonstrations, 12. Lack of educational opportunities about conservation practices, and 9. Did not know about incentive programs. No significant differences existed between levels of demographics and any information/awareness manifest variables. No differences between early and late respondents existed meaning that responders and non-responders are similar.

Programmatic. The third highest latent variable was the programmatic variable. Within that latent variable, manifest variables that averaged from highest to lowest included: 6. Lack of available cost-share funds, 5. Eligibility of a program, 8. Terms of the contract, 7. Land does not meet the requirements of the program. When trying to identify differences between dependent variables and demographics, respondents 51-70 and 71 and over agreed more to programmatic variables than did respondents who ranged between 31 and 50 years of age. Respondents who ranged from 18-30 were not different than either of the two groups. No differences between early and late respondents existed meaning that responders and non-responders are similar.

Producer/Operation. The lowest latent variable was related to producer/operation barriers where the following manifest variables were agreed with by producers most to least: 14. Lack of labor to implement conservation practices, 13. Lack of time to implement/maintain conservation practices, 16. Belief that adopting practices would really make a difference in water quantity and/or water quality, 15. Conservation practices are outside of my methods of operating, 18. Do not want to be tied to a government program, and 17. Operation size is too large to implement practices. Significant differences could be identified between respondents where those 18 – 30 agreed more than respondents 51-70 about the lack of time to implement/maintain conservation practices while respondents 71 and over and 31-50 were not different than the two groups. Also, males agreed more than females with the barrier of whether adopting practices really make a difference. No differences between early and late respondents existed meaning that responders and non-responders are similar.

Objective 4

Ethnicity was the only demographic that contained a significant difference when compared to the variable that asked whether participants had adopted practices or not. White respondents tended to have adopted practices more so than Spanish, Hispanic, or Latino respondents.

Objective 5

There were not differences in responses to manifest variables between those who have and those who have not adopted practices.

Recommendations

With these results, agencies should evaluate how incentive funds are spent within watersheds. To be most effective in implementation, recommendations could be made to cover more of the initial costs for installing in areas of interest, as well as help in maintenance costs. Also, education programs about the various incentive programs (and other programs of interest to agricultural producers) should be continued to ensure that awareness is raised to increase adoption rates. Implementing these two recommendations should reduce the programmatic barriers. Producer/Operation barriers were not considered one of the major barriers and should not be used as a basis for changing implementation; however, such barriers should be kept in mind and continuously observed to ensure that they do not become an issue.

Future activities will consist of aiming to alleviate barriers to adopting sustainable agricultural practices that can be controlled through the provided recommendations above. It is anticipated that adoption rates will increase if barriers can

be alleviated, but a future assessment should be conducted to continue determining barriers and adaptively managing the watershed implementation program.

CHAPTER IV

EVALUATING AGRICULTURAL IMPLEMENTATION EFFORTS OF A WATERSHED PROGRAM IN THE ARROYO COLORADO WATERSHED

Synopsis

The Arroyo Colorado Watershed Protection Plan was developed in response to an impairment in the Arroyo Colorado River, and the Agricultural Issues Workgroup developed a goal of implementing sustainable agricultural practices on 10,000 irrigated acres annually. To accomplish this goal, four types of assistance were to be provided: education, cost-share assistance, technical assistance, and monitoring and assessment. To assess the effectiveness of the program, a questionnaire to evaluate was mailed to a random sample of agricultural producers. Respondents indicated that education was the most effective activity, followed by technical assistance, cost-share assistance, and monitoring and assessment. Manifest variables provide specific variables within each type of assistance. No differences were identified in their response to having heard of the Watershed Protection Plan based on demographics, but those who have heard of the Plan were more likely to have responded as having adopted practices than those who had not heard of it.

Keywords

Watershed, Sustainable Agricultural Practice, Adoption, Program Evaluation

Introduction

The Arroyo Colorado River, located in the Lower Rio Grande Valley of Texas, has been identified as impaired by the Texas Commission on Environmental Quality (2013) for not meeting water quality standards. As a result of this impairment, the Arroyo Colorado Watershed Protection Plan was developed with recommendations from a variety of issue specific workgroups, one of those being the Agricultural Issues Workgroup. This assembly of individuals compiled their recommendations in the Arroyo Colorado Watershed Protection Plan: Components Addressing Agricultural Nonpoint Source Pollution (Agricultural Issues Work Group of the Arroyo Colorado Watershed Partnership, 2006) document, recommending that 10,000 acres of irrigated land be brought under sustainable agricultural practices annually. To accomplish this goal, it was determined that four types of assistance would be needed including: 1) Education, 2) Cost-Share Assistance, 3) Technical Assistance, and 4) Monitoring and Assessment. Since 2007, the Arroyo Colorado Watershed Protection Plan has been implemented, and in Fall 2012, 103,604 acres (R. Ramirez, personal communication, November 20, 2012) had implemented practices, falling short of the established 120,000 acre goal (Agricultural Issues Work Group of the Arroyo Colorado Watershed Partnership, 2006). Overall perceptions of agricultural producers is important to have a successful program because it is people that make changes, not a plan or the science behind a plan. As with any program, an evaluation is needed to determine what has worked, what has not worked, what activities within the program can be enhanced, and what activities within the program have not been worthwhile. Weinstein (2009) wrote that frequent evaluation

is needed to ensure program success over time. Other studies have evaluated barriers to adopting sustainable agricultural practices; therefore, it is not the purpose of this paper to identify barriers, but to evaluate agricultural producer perceptions on selected components of the Arroyo Colorado Watershed Protection Plan.

Watershed programs often implement a variety of projects that aim at accomplishing the interim milestones and, eventually, the overall goals of the program; however, in Texas, programs are often not assessed to determine the overall effectiveness within communities. Brody and Highfield (2005) mention there is a lack of studies that evaluate watershed implementation, and most focus on physical changes that take place, such increased number of wetlands, increased acreage under practices, or changes in water quality. To make this change in water quality, however, you should have a good perception of your program and understand what areas you are currently implementing should be enhanced, changed, or removed.

Programs, as described by Weiss, (1972) are "aimed to change people's knowledge, attitudes, values, behaviors, the institutions with which they deal, or the communities in which they live." Watershed evaluation can come in a variety of methods. The majority of watershed evaluation literature focuses on computer simulation techniques that help agencies target specific implementation; however, without an evaluation of social perceptions, the program goals are unlikely to be successful. Limited literature exists about social evaluations of watershed programs; however, the reason behind conducting an assessment is to yield results that will show where improvements can be made and how improvements can be contributed to the

betterment of society (Mackay & Horton, 2003). Jackson-Smith and McEvoy (2011) assessed the long-term effectiveness of a watershed 15 years after the project began. This evaluation found that producers were more likely to participate in the program for practical reasons and available cost-share money as opposed to environmental concerns. The take away message was that education focusing on environmental impacts of conservation projects would not motivate producers to participate in the program. Another study by Forster and Rausch (2002) evaluated two programs that provide cost share assistance to producers. In this study, it was estimated that almost $143 million was spent on incentive payments in 10 years; however, much of the funding was not spent on the most effective practices in areas with the highest impact for mitigation. This particular study shows the importance of watershed monitoring and assessment projects. Napier and Camboni (1988) collected information in an effort to determine attitudes toward a proposed soil conservation program, and overall, attitudes were positive. This particular study shows the importance of an overall positive or negative perception of program participants and the success of the program.

Overall, evaluation of watershed programs has been a tool that has been underutilized. Nowak (1992) wrote that a "shotgun approach to using technical, financial, and educational assistance is not the answer", and to date, this type of approach continues to be implemented. Through the use of a program evaluation, future efforts can be targeted to specific areas that are needed to enhance the program. The focus of this paper is to:

1. Profile of respondents for proceeding analysis

2. Identify differences in responses between those who have and those who have not heard of the Arroyo Colorado Watershed Protection Plan
3. Identify differences in demographics and those who have and those who have not heard of the Arroyo Colorado Watershed Protection Plan
4. Identify primary areas that need more focus
5. Determine if a difference exists between those who have and those who have not heard of the Arroyo Colorado Watershed Protection Plan on whether they have adopted sustainable practices.

Methods

Using the USDA-FSA Farm Payment Files Information, participants were selected to represent agricultural producers in the Cameron, Hidalgo, and Willacy counties. Individuals from this database as well as contact lists from Texas A&M AgriLife Extension Service County Agents provided an accessible sampling frame of 2,547 individuals. Each individual in the database was assigned a random number and were then sorted from lowest to highest. The first 1,200 participants were selected to participate in the study. Of these, 1,137 were deliverable addresses and 274 (24.1%) participants returned the survey. 11 participants completed the survey online, 91 completed the first mailing, 58 completed the second mailing (resulting in 160 usable responses), and 114 returned the survey opting not to fill it out. Results are perceptions of the respondents and are not to be generalized to the population as a whole.

The survey was developed by the researchers and consisted of twelve Likert scale questions of: Strongly Agree (1), Agree (2), Somewhat Agree (3), Somewhat

Disagree (4), Disagree (5), Strongly Disagree (6). There were also questions with the same Likert scale that asked participants for their level of agreement regarding the four types of assistance that need additional focus. Finally, a question was asked to evaluate whether participants had heard of the Arroyo Colorado Watershed Protection Plan or not, followed by demographics.

To conduct data analysis, Statistical Package for Social Sciences (SPSS) Version 22 was used. Analysis began with calculating descriptive statistics (number and percent) for respondents, followed by descriptive statistics (mean, standard deviation, number) for each of the evaluation barriers by those that have and have not heard of the Arroyo Colorado Watershed Protection Plan and a combination of the two. Next, an ANOVA was used to identify differences among levels of demographics and participants' response to hearing of the Arroyo Colorado Watershed Protection Plan in their response to both latent (construct) and manifest (measurable) variables. Also, an ANOVA was used to identify differences in levels of demographic on responses to whether they had heard of the Plan or not. Descriptive statistics were used to identify respondents preferences in areas where additional focus will be needed in the future, and finally, a factorial ANOVA was conducted using main effects of participants' response to having heard of the Plan and their response to having adopted sustainable agricultural practices or not. All tests of statistical significance were conducted using an *a priori* alpha of .05. To test for differences between responders and non-responders, early respondents and late respondents were compared (Lindner, Murphy, & Briers, 2001).

Results

Objective 1

Table 9 contains levels of demographic characteristics of respondents to the survey that were used to analysis in later objectives. Of the respondents, the majority of the research participants responded as being between the ages of 51-70, male, white, and having a Bachelor's degree; however, other categories also contained responses as well.

Table 9

Demographic Characteristics of Participants

Characteristic	n	%
Age at time of evaluation (years)		
18 - 30	2	1.3
31 - 50	20	12.5
51 - 70	83	51.9
71 and over	47	29.4
Gender		
Male	128	80.0
Female	25	15.6
Ethnicity		
American Indian or Alaska Native	1	.6
Spanish, Hispanic, Latino	58	36.3
White	91	56.9
Education level		
Less than High School	9	5.6
High School Diploma	25	15.6

Table 9 Continued

Characteristic	n	%
Some College	41	25.6
Bachelor's Degree	53	33.1
Post-Graduate Degree	25	15.6

Note. N=160 (Total Population)

Manifest variables, (Table 10) by asking the question of "Please indicate your level of agreement regarding the following," were measured in an attempt to identify successful areas of the agricultural component of the Arroyo Colorado Watershed Protection Plan and also areas that need additional focus. Cronbach's alpha was calculated and resulted in an alpha of .95, indicating that the instrument was reliable. Respondents who had heard of the Arroyo Colorado Watershed Protection Plan, 57 respondents, (35.6%) and 79 had not heard of it (49.4%) was calculated.

Descriptive statistics for manifest variables (Table 10) that made up the latent variables (Table 11) were calculated for both those who were familiar with the Watershed Protection Plan and those who were not. Table 10 contains the descriptive statistics for all manifest evaluation variables where of the education variables, 2. Educational programs related to water and conservation practices have been beneficial, was agreed with the most by respondents (M=3.04, SD, 1.25). Of the cost-share latent variable, the manifest variable that respondents agreed with the most was that 5. cost-share programs have benefited their operation (M=3.42, SD=1.58). Next, within the technical assistance latent variable, respondents agreed most that 7. Technical assistance

for conservation practices has been readily available when it was needed. Finally,, in the monitoring and assessment latent variable, the manifest variable 12. Monitoring results from water conservation practice effectiveness studies made me want to change the way that I manage my operation, was agreed with the most.

Table 10

Manifest Variable Mean, Standard Deviation, and Number of Responses for Participants Who Have and Have Not Heard of the Arroyo Colorado Watershed Protection

Manifest Variable		M	SD	N
1. Educational programs related to water and conservation practices have occurred often enough	Yes	3.48	1.44	66
	No	3.06	1.33	52
	Total	3.30	1.40	118
2. Educational programs related to water and conservation practices have been beneficial	Yes	3.15	1.35	66
	No	2.90	1.10	51
	Total	3.04	1.25	117
3. As a result of educational programs related to water and conservation practices, you have made changes to your operation	Yes	3.18	1.42	66
	No	3.56	1.35	52
	Total	3.35	1.40	118
4. Additional money has come to the Rio Grande Valley for cost-share programs in the last 5 years	Yes	3.64	1.37	66
	No	3.57	1.39	51
	Total	3.61	1.37	117

Table 10 Continued

Manifest Variable		M	SD	N
5. Cost-share programs have benefited your operation	Yes	3.22	1.65	68
	No	3.69	1.45	51
	Total	3.42	1.58	119
6. Cost-share assistance has been available when you attempted to apply through various agencies	Yes	3.30	1.55	66
	No	3.70	1.34	50
	Total	3.47	1.47	116
7. Technical assistance for conservation practices has been readily available when it was needed	Yes	3.02	1.41	66
	No	3.48	1.37	50
	Total	3.22	1.41	116
8. Technical assistance was used when installing water conservation practices	Yes	3.02	1.46	64
	No	3.63	1.44	49
	Total	3.28	1.48	113
9. You benefited from available technical assistance	Yes	3.02	1.52	62
	No	3.68	1.43	50
	Total	3.31	1.51	112
10 Monitoring results from water conservation practice effectiveness studies were made available upon completion of a project	Yes	3.79	1.47	61
	No	3.80	1.44	49
	Total	3.79	1.45	110
11 Monitoring results from water conservation practice effectiveness studies were useful	Yes	3.75	1.41	63
	No	3.65	1.56	49

Table 10 Continued

Manifest Variable		M	SD	N
	Total	3.71	1.47	112
12. Monitoring results from water conservation practice effectiveness studies made me want to change the way that I manage my operation	Yes	3.44	1.39	63
	No	3.57	1.47	49
	Total	3.50	1.42	112

Note. Scale: 1.00-1.49 = "strongly agree;" 1.50-2.49 = "agree;" 2.50-3.49 = "somewhat agree;" 3.50-4.49 = "somewhat disagree;" 4.50-5.49 = "disagree;" 5.50-6.49 = "strongly disagree."

Next, latent variables were calculated to identity successful areas of the program. Cronbach's alpha was calculated for each latent variable and resulted in .79 for education, .87 for cost-share, .94 for technical assistance, and .92 for monitoring and assessment variables. Table 11 contains descriptive statistics for latent variable and participants' response to whether they have heard of the Watershed Protection Plan. Of the latent variables, education activities (M=3.21, SD=1.17) were perceived to be the most effective, and monitoring and assessment (M=3.66, SD=1.35) activities were perceived to be the least effective. There were no significant differences between those that responded as having heard of the Arroyo Colorado Watershed Protection Plan and those that have not on their responses to the latent variables.

Table 11

Latent Variable Mean, Standard Deviation, and Number of Responses for Participants Who Have and Have Not Heard of the Arroyo Colorado Watershed Protection Plan

Latent Variable		M	SD	N
Education	Yes	3.24	1.25	67
	No	3.17	1.07	52
	Total	3.21	1.17	119
Cost-Share	Yes	3.37	1.36	69
	No	3.64	1.30	51
	Total	3.49	1.34	120
Technical Assistance	Yes	3.01	1.37	66
	No	3.60	1.33	50
	Total	3.26	1.38	116
Monitoring and Assessment	Yes	3.66	1.30	63
	No	3.67	1.43	49
	Total	3.66	1.35	112

Note. Scale: 1.00-1.49 = "strongly agree;" 1.50-2.49 = "agree;" 2.50-3.49 = "somewhat agree;" 3.50-4.49 = "somewhat disagree;" 4.50-5.49 = "disagree;" 5.50-6.49 = "strongly disagree."

Objective 2

An ANOVA was conducted to identify differences in those who have and have not heard of the Arroyo Colorado Watershed Protection Plan and their response to the different latent and manifest variables. Each of the significant variables is identified below.

Education. There was no significant difference between participants who have and have not heard of the Arroyo Colorado Watershed Protection Plan and their response to the both education latent and manifest variables.

Also, no significant differences existed between early and late respondents to the variables "1. Educational programs related to water and conservation practices have occurred often enough" ($p = 0.08$), "2. Educational programs related to water and conservation practices have been beneficial" ($p = 0.94$), and "3. As a result of educational programs related to water and conservation practices, you have made changes to your operation" ($p = 0.39$) indicating that responders were no different than non-responders.

Cost-share. A statistically significant difference in the success of cost-share [$F(1,121) = 4.85$, $p = .03$] ($\eta_p^2 = 0.03$, $1- \beta = 0.59$, $M=3.52$, $SD=1.35$) was identified between participants who had ($M=3.23$, $SD=1.23$) and had not ($M=3.76$, $SD=1.40$) heard of the Arroyo Colorado Watershed Protection Plan and their response to the latent variable. A significant difference [$F(1,118) = 6.24$, $p = .01$] ($\eta_p^2 = 0.05$, $1- \beta = 0.70$, $M=3.61$, $SD=1.40$) was identified between participants response to "4. Additional money has come to the Rio Grande Valley for cost-share programs in the last 5 years" based on whether they had ($M=3.26$, $SD =1.36$) or had not ($M=3.89$, $SD=1.37$) heard of the Arroyo Colorado Watershed Protection Plan.

No significant differences existed between early and late respondents to the variables "4. Additional money has come to the Rio Grande Valley for cost-share programs in the last 5 years" ($p = 0.80$), "5. Cost-share programs have benefited your

operation" (p = 0.31), and "6. Cost-share assistance has been available when you attempted to apply through various agencies" (p = 0.83) meaning that responders were not different than non-responders.

Technical assistance. There was a significant difference in the perception success of technical assistance [F(1,117) = 5.52, p = .02] (η_p^2 = 0.05, 1- β = 0.64, M=3.33, SD=1.41) identified between participants who have (M=2.98, SD=1.29) and have not (M=3.29, SD=1.19) heard of the Arroyo Colorado Watershed Protection Plan. Analysis in the manifest variable determined that a difference could be found [F(1,117) = 4.12, p = .05] (η_p^2 = 0.03, 1- β = 0.52, M=3.26, SD=1.43) in those who have (M=2.96, SD=1.3) and those who have not (M=3.49, SD=1.49) and their response to "7. Technical assistance for conservation practices has been readily available when it was needed." Similarly, those who have (M=2.94, SD=1.41) and have not (M=3.68, SD=1.53) heard of the Plan contained a significant difference [F(1,114) = 7.02, p=.009] (η_p^2 = 0.06, 1- β = 0.58, M=3.36, SD=1.52) in their response to "8. Technical assistance was used when installing water conservation practices". Finally, those who know of the plan (M=3.02, SD=1.42) significantly agree more [F(1,113) = 4.76, p=.03] (η_p^2 = 0.04, 1- β = 0.58, M=3.39, SD=1.55) than those who have not heard of the plan (M=3.65, SD=1.59) about "9. You benefited from available technical assistance."

No significant differences existed between early and late respondents to the variables "7. Technical assistance for conservation practices has been readily available when it was needed" (p = 0.30), "8. Technical assistance was used when installing water conservation practices" (p = 0.35), and "9. You benefited from available technical

assistance" ($p = 0.76$) indicating that there is likely no difference between responders and non-responders.

Monitoring and assessment. A significant difference [$F(1,113) = 8.1$, $p = .005$] ($\eta_p^2 = 0.07$, $1- \beta = 0.81$, $M=3.69$, $SD=1.37$) was found between participants who have ($M=3.29$, $SD=1.19$) and have not ($M=4.01$, $SD=1.42$) heard of the Arroyo Colorado Watershed Protection Plan and their response to monitoring and assessment latent variable. Within the manifest variable of "10 Monitoring results from water conservation practice effectiveness studies were made available upon completion of a project," there was a significant difference [$F(1,111) = 4.17$, $p=.04$] ($\eta_p^2 = 0.04$, $1- \beta = 0.53$, $M=3.85$, $SD=1.47$) between those who have ($M=3.53$, $SD=1.36$) and those who have not (4.10, $SD=1.52$) heard of the Plan. Next, a significant difference [$F(1,113) = 9.22$, $SD=.003$] ($\eta_p^2 = 0.08$, $1- \beta = 0.85$, $M=3.73$, $SD=1.51$) could be identified between the manifest variable "11 Monitoring results from water conservation practice effectiveness studies were useful" where respondents who have ($M=3.26$, $SD=4.09$) agreed more than respondents who have not ($M=4.09$, 1.54) heard of the plan. Finally, a significant difference [$F(1,112) = 6.76$, $p = .01$] ($\eta_p^2 = 0.06$, $1- \beta = 0.73$, $M=3.51$, $SD=1.45$) was identified between those who had ($M=3.512$, $SD=1.26$) and those who had not ($M=3.81$, $SD=1.52$) heard of the Arroyo Colorado Watershed Protection Plan in their response to "12. Monitoring results from water conservation practice effectiveness studies made me want to change the way that I manage my operation".

No significant differences existed between early and late respondents to the variables "10. Monitoring results from water conservation practice effectiveness studies

were made available upon completion of a project" (p = 0.24), "11. Monitoring results from water conservation practice effectiveness studies were useful" (p = 0.96), and "12. Monitoring results from water conservation practice effectiveness studies made me want to change the way that I manage my operation" (p = 0.87) meaning that responders and non-responders did not differ in what they responded.

Objective 3

No statistically significant relationships existed in levels of demographics and responses to whether they had heard of the Arroyo Colorado Watershed Protection Plan or not.

Objective 4

Questions were asked of the respondents that related directly to where additional focus should be in future implementation efforts. A majority of respondents indicated that additional focus should be placed on cost-share assistance (M=1.74, SD=.97, N=128), followed closely by technical assistance (M=1.74, SD=1.06, N=126), education, (M=1.78, SD=.92, N=128) and finally monitoring and assessment (M=1.82, SD=.99, N=125).

Objective 5

Of the respondents, 75 (46.9%) indicated that they have adopted sustainable agricultural practices, while 58 (43.6%) indicated that they have not adopted. As indicated earlier, 57 (35.6%) have heard of the Arroyo Colorado Watershed Protection Plan, and 79 (49.4%) have not. A statistically significantly difference [F(1,124) = 6.58, p = .01] was identified between those who have (M=1.3, SD=.46) and those who have not

(M=1.53, SD=.50) heard of the Plan and their response to adopting sustainable agricultural practices.

Discussion and Conclusions

Objective 1

Monitoring and assessment related variables were the least effective of the four types of assistance, indicating that additional time should be spent studying the impacts of sustainable agricultural practices, and then informing producers of the effectiveness of those practices. Also, education latent variables were agreed with the most, indicating that this was the type of assistance that was the most effective. Specifically, education programs related to water conservation practice have been beneficial; however, participants did not respond as highly about the program occurring often enough, indicating that education programs should occur more often. Cost-share assistance was also an area that could be improved in the program. Respondents did not very strongly agree that cost-share was beneficial or available; therefore, future efforts should aim at making cost-share assistance more available so that future adopters can find more benefit in the programs on their farms and see that the program is beneficial for the area as a whole. Technical assistance was one type of assistance that respondents highly agreed with so no changes would be recommended for that aspect of the program. Overall, more respondents have not heard of the Arroyo Colorado Watershed Protection Plan than have heard of it. Within latent variables, the following manifest variables ranked from highest to lowest within each one.

Education

- 2. Educational programs related to water and conservation practices have been beneficial
- 1. Educational programs related to water and conservation practices have occurred often enough
- 3. As a result of educational programs related to water and conservation practices, you have made changes to your operation

Technical Assistance

- 7. Technical assistance for conservation practices has been readily available when it was needed
- 8. Technical assistance was used when installing water conservation practices
- 9. You benefited from available technical assistance

Cost-Share Assistance

- 5. Cost-share programs have benefited your operation
- 6. Cost-share assistance has been available when you attempted to apply through various agencies
- 4. Additional money has come to the Rio Grande Valley for cost-share programs in the last 5 years

Monitoring and Assessment

- 12. Monitoring results from water conservation practice effectiveness studies made me want to change the way that I manage my operation

- 11. Monitoring results from water conservation practice effectiveness studies were useful
- 10 Monitoring results from water conservation practice effectiveness studies were made available upon completion of a project

Objective 2

Of all four types of assistance, it seemed that those who had heard of the Arroyo Colorado Watershed Protection Plan agreed more with the value of implementation variables. Specifically, cost-share assistance, technical assistance, and monitoring and assessment contained statistically significant differences where monitoring and assessment contained the most differences. This indicates that agricultural producers familiar with the reasons behind adopting practices agree more that monitoring results have encouraged producers to adopt practices.

Education. There were no significant differences between participants that have and have not heard of the Arroyo Colorado Watershed Protection Plan and their response to education latent and manifest variables. There was also no significant difference between early and late responders indicating that responders and non-responders should be similar.

Cost-share. Respondents who had heard of the Watershed Protection Plan agreed more with the cost-share latent variable than those who had not. Also, respondents who have heard of the Arroyo Watershed Plan agreed more that money has come to the Rio Grande Valley for cost-share programs. Finally, responders and non-

responders were similar which was drawn from no significant difference existing between early and late responders.

Technical assistance. Those who had heard of the Arroyo Colorado Watershed Protection Plan agreed that technical assistance was more effective than those who had not heard of the plan. Additionally, those who have heard of the Plan agreed more that technical assistance was available when it was needed and that it was used when they installed conservation practices. Respondents who have heard of the plan agreed more that they benefited from technical assistance than those who have not. Finally, early and late respondents did not differ in their response to variables, indicating that responders and non-responders likely would not differ in their response.

Monitoring and assessment. Those who have heard of the Arroyo Colorado Watershed Protection plan agreed more than those who have not heard of it that monitoring and assessment activities were effective. Further, respondents who have heard of the plan agreed more than those who have not heard of the Plan that monitoring results were made available upon completion of the project and that monitoring results were useful. Respondents who have heard of the plan agreed more than those who have not heard of the plan that studies made them want to change the way they manage their operation. There was also no significant difference between early and late responders indicating that responders and non-responders should be similar.

Objective 3

There was that there were no difference between levels of demographics and whether they have or have not heard of the Arroyo Colorado Watershed Protection Plan,

indicating that the program has been equally effective in spreading their efforts throughout the watershed.

Objective 4

According to respondents, cost-share assistance was the area for which they would like to see additional focus, followed by technical assistance, education, and monitoring and assessment.

Objective 5

Those who had heard of the Watershed Protection Plan were more likely to have adopted sustainable agricultural practices than those who have not heard of the Plan. This finding demonstrates the overall effectiveness of the Plan and how it has impacted the adoption rate of practices.

Recommendations

Through this study, education seemed to be the most effective area of implementation, followed by technical assistance, cost-share assistance, and finally monitoring and assessment. Recommendations can be made to increase the monitoring and assessment projects and educational programs, using the monitoring project as demonstration type programs so that agricultural producers can observe the effectiveness of the individual practices. Also, recommendations are to increase the amount of cost-share available to agricultural producers so that when funds are applied for, they are readily available which has not always been the case in the project area. Through implementing these recommendations, barriers to adopting practices will be reduced and as a result, adoption rates of sustainable agricultural practices should increase. Other

future efforts will consist of continuing and enhancing areas of the program that have been effective, but also paying special attention to those areas that producers agreed with less in the study.

Future research should consist of reevaluating the overall efforts, both process and outcome, to ensure that changes have been effectively made. Evaluations should occur every five to seven years such that when the watershed protection plan is update, coordinators will be able to identify areas that need additional focus. Also, evaluations should be conducted in other watersheds to identify areas that are needing additional focus statewide and not solely in the Arroyo Colorado Watershed.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

Water quality can be difficult to manage for a watershed in its entirety, especially when there is a large population in the watershed. In the case of the Arroyo Colorado watershed, one of those populations consists of agricultural producers. As discussed in the previous chapters, there is a need to prioritize the approach taken when implementing agricultural components of watershed based plans. This study aimed to answer the following three questions:

1. What are the primary educational needs for agricultural producers in Cameron, Hidalgo, and Willacy counties related to water?
2. What are the primary barriers to management practice adoption through incentive programs?
3. What areas of the agricultural component of the Arroyo Colorado Watershed Protection Plan have been implemented effectively according to agricultural producer perception?

Each of the questions focused on achieving different objectives. Chapter 1 outlines the theoretical framework of which the research questions were derived. The introduction focused on providing background information as to why watershed based plans are developed, followed by background of the Arroyo Colorado Watershed Protection Plan, a watershed based plan that has received much attention between 1999 –

2014 and is continuing into the unforeseeable future. A primary component of that plan was developed to address agricultural contributions to the water quality impairment; however, recent implementation efforts have not been able to meet goals originally outlined. Because of this, watershed managers have developed a theoretical model that outlines interim activities that should be conducted to prioritize future efforts. Information for this theoretical framework was collected from agricultural producers in Cameron, Hidalgo, and Willacy counties, located in the Lower Rio Grande Valley of Texas. Mailed post cards and surveys were developed by the researcher and were sent to approximately 1,200 agricultural producers following Dillman's (2000) Tailored Design Method. A response rate of 24.1% was achieved.

Conclusions and Recommendations

Research Question 1

The first research question of the study, what are the primary educational needs for agricultural producers in Cameron, Hidalgo, and Willacy counties related to water, was answered by calculating means for each of the manifest (measurable) variables and by combining manifest variables into latent (construct) variables to provide overall priority areas. Bridges (2008) had mentioned the necessity of identifying local needs and Feather and Amacher (1994) discussed the lack of information available to help producers make decisions, both contributing to the lack of adoption. Within the study, it was determined that of the latent variables, water quantity was the highest educational need, followed by water quality, financial incentives, and conservation practices. Manifest variables that made up latent variables and were agreed with the most were

how much irrigation water is available for the upcoming year, how water quality impacts your operation, specific conservation practices that reduce the amount of irrigation water used, what current water quality levels are (e.g., nutrients, salinity, etc.) and how to apply for financial incentives. Ribaudo and Horan (1999) mentioned that education is a common component of nonpoint source programs and also mentions that it is less expensive to deliver than cost-share programs. By delivering intensive educational programs, we could possibly help producers make the connection between different parameters and local water quality (Christenson & Norris, 1983).

Some statistically significant differences in participants' response to manifest and latent variables could be identified based on levels of demographic information. Specifically, those with less than high school were different than those with a high school diploma in their response to water quality variables. Also, those with less than high school and bachelor's degree agreed more that they were interested in how water quality impacts their operation. Respondents with less than high school agreed more with the educational need of how agricultural production impacts their operation and what current water quality levels are than those with a high school diploma. Females agreed more than males to the educational need of specific water conservation practices that improve water quality. Lastly, of the financial incentive variables, differences could be identified between females and males where females agreed more than males to the educational need of requirements of financial incentive programs.

Research Question 2

There is a need to identify these barriers at the local level because of varying barriers across the state and the lack of commonality and some authors have even stated that "results are clearly inconclusive about what factors consistently determine BMP adoption" (Prokopy et al., (2008). The second research question of what are the primary barriers to management practice adoption through incentive programs, was answered by focusing on the following objectives:

1. Identify specific, priority barriers to adopting sustainable agricultural practices
2. Classify overall broad categories of barriers to adopting sustainable agricultural practices
3. Identify differences in manifest and latent variables amongst demographics
4. Identify differences in demographics on whether they have adopted or not
5. Identify differences in manifest and latent variables between adopters and non-adopters of sustainable agricultural practices

First, means were calculated to identify which were the primary barriers to adopting sustainable agricultural practices. Also, manifest variables were combined into latent variables to identify the key areas that barriers fall into. Of the barriers, the initial cost of installing was the barrier that agricultural producers agreed with the most. The barrier agreed with the second most was that cost-share levels were too low, followed by the lack of cost-share funds available. Finally, the fourth highest barrier was related to maintenance costs of the practices. All of these barriers were related to economics, which was the area relating to the largest barrier, or latent variable, supporting

Rodriguez et al (2008), and Drost et al (1996); however, for the purposes of this study, the lack of cost-share funds and cost-share levels being too low were part of the programmatic barrier. Of the remaining latent barriers, information/awareness ranked second (supporting Gillespie et al. (2007), Baumgart-Getz et al. (2012), Greiner et al. (2009), and Ryan et al (2003)), programmatic third, and producer/operation fourth (supporting Lamba et al. (2008)).

Of these manifest variables, significant differences could be identified between those that have adopted practices (agreeing less) and those that have not adopted (agreeing more) in their response to four manifest variables, meaning that those that have not adopted practices were more likely to agree less. Those manifest variables were "4. Uncertain if practices will increase or decrease profit," "7. Land does not meet the requirements of the program," "14. Lack of labor to implement conservation practices," and "15. Conservation practices are outside of my methods of operating."

Statistically significant differences could be identified between levels of demographics and their response to the barrier variables. For economic barriers, there were significant differences identified among levels of age. Specifically, respondents 31-70 tended to agree less than those 18-30 and 71 and over. Participants 18-30 and 71 and over agreed more that the initial cost of installing was a barrier than respondents 51-70; however, those 31-50 were not different than the two groups. Respondents with less than high school indicated that cost-share levels were too low more than other groups and the same group also agreed more that uncertainty about practices increasing or decreasing profit was more of a barrier than those with some college.

Within information/awareness variables, there were no significant differences in respondent levels of demographics. A single difference existed within levels of demographics and programmatic latent variable where respondents above 51 agreed more than respondents 31-50 years of age. Those 18-30 were not different than either group. A difference could be identified where participants 18-30 agreed more than those 51-70 about the lack of time to implement/maintain conservation practices. Males also agreed more than females that the variable of whether adopting a practice or not was a barrier.

Of those who had adopted sustainable agricultural practices, a significant difference could be identified between White respondents and Spanish, Hispanic, or Latino respondents where White respondents were more likely to adopt. There were no differences in those who had adopted and those who had not in their response to manifest variables.

Research Question 3

Agricultural producers are responsible for making decisions on their operation; therefore, convincing them that sustainable agricultural practices are needed is very important. Also, knowing their perceptions of the program and the area that needs improvement or additional focus is very important. Brody and Highfield (2005) discussed the lack of studies about community effectiveness and watershed management and the Arroyo Colorado watershed was no different. To answer the third research question of: what areas of the agricultural component of the Arroyo Colorado Watershed

Protection Plan have been implemented effectively according to agricultural producer perception, the following objectives were pursued:

1. Determine descriptive statistics of respondents
2. Identify differences in responses between those who have and those who have not heard of the Arroyo Colorado Watershed Protection Plan
3. Identify differences in demographics and those who have and have not heard of the Arroyo Colorado Watershed Protection Plan
4. Identify primary future areas that need more focus
5. Determine if a difference exists between those who have heard and those who have not heard of the Arroyo Colorado Watershed Protection Plan on whether they have adopted sustainable practices or not

Of the descriptive statistics calculated for Objective 1, monitoring and assessment related variables were agreed with the least. Education variables were agreed with the most, indicating that this area of the program was the most effective. Education was followed by technical assistance and cost-share assistance latent variables.

An ANOVA was conducted to identify significant differences between those who have and have not heard of the Arroyo Colorado Watershed Protection Plan and responses to manifest variables. There were no differences between education related manifest variables; however, those who have heard of the Plan agreed more with cost-share latent variables and the manifest variable of additional money has come to the Rio Grande Valley for cost-share programs than those who have not heard of the Plan. Respondents who have heard of the Plan agreed more that technical assistance was

effective than those who have not. Of the manifest variables, respondents who have heard of the Arroyo Colorado Watershed Protection Plan agreed more than those who have not heard of it that technical assistance was available when it was needed, that it was used when practices were installed, and that it was beneficial. Finally, those who have heard of the plan agree more than those who have not that monitoring and assessment activities were effective, that monitoring results were made available upon completion of a project, and that studies made them want to change the way they managed their operation.

Statistically significant differences could not be identified between demographics and whether they have heard of the Arroyo Colorado Watershed Protection Plan or not.

Future areas of the project should focus on cost-share assistance (consistent with the short falling of the original goal outlined in chapter 1), followed by technical assistance, education, and monitoring and assessment.

Finally, those who have heard of the Arroyo Colorado Watershed Protection plan were more likely to have adopted practices than those who have not heard of the Plan.

Implications for Watershed Implementation

Alonge and Martin (1995) discuss the importance of assessing local needs and understanding those needs and using the results of this research will provide direction for future implementation of the agricultural components of the Arroyo Colorado Watershed Protection Plan. Shepard (1999) wrote that education programs provide information to agricultural producers that encourages the adoption of sustainable agricultural practices; therefore, educational programs should consist of several different messages. First, a

program should provide producers with information about: how much water will be available for the upcoming year, new technologies that reduce water quantity being used, how irrigation water could impact the producers operation, and how to manage to alleviate potential negative effects of irrigation water. Second, education programs should highlight water quality related projects, but focus on technical aspects of financial incentive programs, what they are, what they consist of, where they can be accessed, and how to sign up for them. Part of this message would include a discussion about water quality and how the financial incentive programs aim to improve water quality. Finally, specific programs related to the technical aspects of conservation practices should be delivered. In the previous two programs, producers will become aware of conservation practices and how they can reduce water used or improve water quality, but will need to know what they consist of. With these three education programs, awareness of ongoing programs will not only be increased, but producers will be receiving relevant information.

Recommendations to reduce barriers to adopting practices are as follows and should alleviate them by addressing two reasons for non-adoption, 1) being unable to adopt, and 2) being unwilling to adopt, both identified by Nowak (1992). Agencies should increase the amount of cost-share to pay for the initial cost of management practices, keep incentive programs funded so that finances are available when producers attempt to sign-up, devise a system that helps fund maintenance costs of select practices, increase the amount of education programs about incentive programs and practice effectiveness by providing funding for such programs which would increase the number

of opportunities to see practices in the field and allow educators to discuss technical aspects of practices and financial incentive programs. Feather and Amcher (1994) mention the importance of such programs where producers' uncertainty in practices is reduced, thus increasing the adoption of practices.

Finally, the current program should place additional focus on the monitoring and assessment component and make results of those programs available to producers, consistent with Rogers (1995) components of an innovation. Keeping financial incentive programs funded so that finances are available is important to the success of the program, and when paired with messages of effectiveness results of monitoring and assessment, adoption rates would be much larger. Also, education programs should continue, but at an increased rate, because while this was the most successful aspect of the program, it has the potential to be much more successful. Lastly, those who had heard of the Arroyo Colorado Watershed Protection Plan were more likely to have responded as having adopted sustainable agricultural practices; therefore, the more awareness that is raised within the population, the more likely adoption of practices will be increased.

Recommendations for Further Research

Bridges (2008) discussed the importance of conducting local needs so that effective programs can be delivered in the future. This was a similar finding identified through this research as local needs seemed to be of a different priority than other areas of Texas, likely a result of the nature of local agricultural production, climate differences and a variety of other factors. Recommendations from this research is to develop (or

enhance) an irrigation training program that covers a variety of aspects including water quantity management, water quality management, sources of financial incentives (with current funding) that will cost-share such water quantity and quality conservation practices and evaluate the effectiveness of such program not only through post-test surveys, but also measured against the number of practices implemented through incentive programs.

Future research should also consist of identifying educational needs in other areas of the state and comparing to identify similarities. These similar topics should be developed into a statewide educational program whereas other issues should be addressed at the local level. Also, barriers to adopting sustainable agricultural practices should be assessed within the Arroyo Colorado Watershed again every five years to identify trends and needs of the changing demographics. The same barriers should also be assessed in other areas of the state to see if any major policy changes should be made. Finally, the local perception of Arroyo Colorado Watershed Protection Plan implementation should continue to be assessed to ensure that programs of interest are being delivered and that gaps are being filled.

REFERENCES

Alonge, A. J., & Martin, R. A. (1995). Assessment of the adoption of sustainable agriculture practices: Implications for agricultural education. *Journal of Agricultural Education*, *36*(3), 34-42. doi:10.5032/jae.1995.03034

Arroyo Colorado Watershed Partnership. (2007). *A watershed protection plan for the Arroyo Colorado phase I*. Retrieved from: http://arroyocolorado.org/media/2639/watershedprotectionplan.pdf

Agricultural Issues Work Group of the Arroyo Colorado Watershed Partnership. (2006). *Arroyo Colorado watershed protection plan: Components addressing agricultural nonpoint source pollution*. Retrieved from: http://arroyocolorado.org/media/2632/componentsaddressingagnsp.pdf

Barrick, R. K. (1989). Agricultural education: Building upon our roots. *Journal of Agricultural Education*, *30*(4), 24-29. doi:10.5032/jae.1989.04024

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management*, *96*(1), 17-25. doi:10.1016/j.jenvman.2011.10.006

Brezonik, P. L., Easter, K. W., Hatch, L., Mulla, D., & Perry, J. (1999). Management of diffuse pollution in agricultural watersheds: Lessons from the Minnesota River Basin. *Water Science and Technology*, *39*(12), 323-330.

Bridges, C. A. (2008). Identifying agriculture and forestry educational needs using spatial analysis techniques. *Journal of Extension,[Online]*, *46*(3). Retrieved from http://www.joe.org/joe/2008june/tt6.php

Brody, S. D., & Highfield, W. E. (2005). Does planning work? Testing the implementation of local environmental planning in Florida. *Journal of the American Planning Association*, *71*(2), 159-175. doi:10.1080/01944360508976690

Cash, D. W. (2001). In order to aid in diffusing useful and practical information: Agricultural extension and boundary organizations. *Science, Technology & Human Values*, *26*(4), 431-453. doi: 10.1177/016224390102600403

Christensen, L. A., & Norris, P. E. (1983). Soil conservation and water quality improvement: What farmers think. *Journal of Soil and Water Conservation*, *38*(1), 15-20. Retrieved from http://www.jswconline.org/content/38/1/15.full.pdf+html

Dillman, D. (2000). *Mail and internet surveys: The tailored design method* (2nd ed.). New York, NY: John Wiley & Sons, Inc.

Drost, D., Long, W., Wilson, D., Miller, B., & Campbell, W. (1996). Barriers to adopting sustainable agricultural practices. *Journal of Extension*, *34*(6). Retrieved from http://www.joe.org/joe/1996december/a1.php

Feather, P. M., & Amacher, G. S. (1994). Role of information in the adoption of best management practices for water quality improvement. *Agricultural Economics*, *11*(2), 159-170. Retrieved from http://www.sciencedirect.com/science/article/pii/0169515094000131

FindLaw. (2013). *Tex ag. code ann. section 201.026: Texas statutes-section 201.026*. Retrieved from website: http://codes.lp.findlaw.com/txstatutes/AG/7/201/B/201.026

Ford, C. L. (1995). Educational priorities of small farmers in west Tennessee. *Journal of Agricultural Education*, *36*(1), 31-37. doi:10.5032/jae.1995.01031

Forster, D. L., & Rausch, J. N. (2002). Evaluating agricultural nonpoint-source pollution programs in two Lake Erie tributaries. *Journal of Environmental Quality*, *31*(1), 24-31. Retrieved from https://www.agronomy.org/publications/jeq/pdfs/31/1/24

Gamon, J., Harrold, N., & Creswell, J. (1994). Educational delivery methods to encourage adoption of sustainable agricultural practices. *Journal of Agricultural Education*, *35*(1), 38-42. doi:10.5032/jae.1994.01038

Gillespie, J., Kim, S., & Paudel, K. (2007). Why don't producers adopt best management practices? An analysis of the beef cattle industry. *Agricultural Economics*, *36*(1), 89-102. doi:10.1111/j.1574-0862.2007.00179.x

Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems*, *99*(2), 86-104. doi:10.1016/j.agsy.2008.10.003

Houck, O. A. (1999) *The Clean Water Act TMDL program: Law, policy, and implementation*. Washington, DC: Environmental Law Institute.

Jackson-Smith, D. B., & McEvoy, J. P. (2011). Assessing the long-term impacts of water quality outreach and education efforts on agricultural landowners. *The Journal of Agricultural Education and Extension*, *17*(4), 341-353. doi:10.1080/1389224x.2011.576823

Kannan, N. (2012). *Swat modeling of the Arroyo Colorado watershed* (Texas Water Resources Institute, Technical Report 426). Retrieved from website: http://twri.tamu.edu/reports/2012/tr426.pdf

Kitchen, N. R., Snyder, C. J., Franzen, D. W., & Wiebold, W. J. (2002). Educational needs of precision agriculture. *Precision Agriculture*, *3*(4), 341-351. Retrieved from http://link.springer.com/article/10.1023/A:1021588721188

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, *32*(1), 25-48. doi:10.1016/j.foodpol.2006.01.003

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy* (2nd ed.). New York, NY: Cambridge Books.

Knowles, M. S. (1984). *The adult learner: A neglected species* (3rd ed.). Houston, TX:Gulf.

Lamba, P., Filson, G., & Adekunle, B. (2009). Factors affecting the adoption of best management practices in southern Ontario. *The Environmentalist*, *29*(1), 64-77. doi:10.1007/s10669-008-9183-3

Lindner, J. R., Murphy, T. H., & Briers, G. E. (2001). Handling nonresponse in social science research. *Journal of Agricultural Education*, *42*(4), 43-53.

Mackay, R., & Horton, D. (2003). Expanding the use of impact assessment and evaluation in agricultural research and development. *Agricultural Systems*, *78*(2), 143-165. doi:10.1016/S0308-X(03)00124-0

Napier, T. L., & Camboni, S. M. (1988). Attitudes toward a proposed soil conservation program. *Journal of Soil and Water Conservation*, *43*(2), 186-191.

Nowak, P. (1992). Why farmers adopt production technology: Overcoming impediments to adoption of crop residue management techniques will be crucial to implementation of conservation compliance plans. *Journal of Soil and Water Conservation*, *47*(1), 14-16. Retrieved from http://www.jswconline.org/content/47/1/14.full.pdf+html

Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation*, *63*(5), 300-311. Retrieved from http://www.jswconline.org/content/63/5/300.full.pdf+html

Reganold, J. P., Papendick, R. I., & Parr, J. F. (1990). Sustainable agriculture. *Scientific American*, *262*(6), 112-120. Retrieved from http://oregonstate.edu/instruct/bi430-fs430/Documents-2004/7B-MIN%20TILL%20AG/Sustainable%20Agr%C3%89hn%20Reganold.pdf

Reimer, A. P., Weinkauf, D. K., & Prokopy, L. S. (2011). The influence of perceptions of practice characteristics: An examination of agricultural best management

practice adoption in two Indiana watersheds. *Journal of Rural Studies*. *28*(1), 118-128. doi:10.1016/j.jrurstud.2011.09.005

Ribaudo, M. O., & Horan, R. D. (1999). The role of education in nonpoint source pollution control policy. *Review of Agricultural Economics*, *21*(2), 331-343. doi:10.2307/1349883

Rodriguez, J. M., Molnar, J. J., Fazio, R. A., Sydnor, E., & Lowe, M. J. (2008). Barriers to adoption of sustainable agricultural practices: Change agent perspectives. *Renewable Agricultural Food Systems, 24*(1), 60-71. doi:10.1017/S1742170508002421

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York, NY: Free Press.

Ryan, R. L., Erickson, D. L., & De Young, R. (2003). Farmers' motivations for adopting conservation practices along riparian zones in a mid-western agricultural watershed. *Journal of Environmental Planning and Management*, *46*(1), 19-37. doi:10.1080/713676702

Shepard, R. (1999). Making our nonpoint source pollution education programs effective. *Journal of Extension*, *37*(5), n5. Retrieved from http://www.joe.org/joe/1999october/a2.php

Supalla, R. J., Selley, R. A., Bredeweg, S., & Watts, D. (1995). Adoption of nitrogen and water management practices to improve water quality. *Journal of Soil and Water Conservation*, *50*(1), 77-82. Retrieved from http://www.jswconline.org/content/50/1/77.full.pdf+html

Texas Commission on Environmental Quality. (2013, February 13). *Draft 2012 Texas integrated report - Texas 303(d) list (category 5)*. Retrieved from http://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/12twqi/2012_303d.pdf

Texas State Soil and Water Conservation Board. (n.d.). *Texas nonpoint source management program* . Retrieved from http://www.tsswcb.texas.gov/managementprogram

Texas State Soil and Water Conservation Board. Texas State Soil and Water Conservation Board. (2010). *Reference guide for a water quality management program to address agricultural and silvicultural nonpoint source pollution*. Retrieved from: http://www.tsswcb.texas.gov/files/docs/nps-wqmp/SB503Manual_Revised_.pdf

Tilman, D. (1999). Global environmental impacts of agricultural expansion: The need for sustainable and efficient practices. *Proceedings of the National Academy of Sciences*, *96*(11), 5995-6000. doi:10.1073/pnas.96.11.5995

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, *418*(6898), 671-677. doi:10.1038/nature01014

United Nations. United Nations, Economic & Social Affairs. (2013). *World population prospects, the 2012 revision* (ST/ESA/SER.A/336). Retrieved from: http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2012_Volume-I_Comprehensive-Tables.pdf

United States Department of Agriculture Natural Resource Conservation Service, (2003). *Technical report: Barriers and strategies influencing the adoption of nutrient management practices* (13.1). Retrieved from website: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045633.pdf

United States Environmental Protection Agency. (March 2012). *Clean water act section 303*. Retrieved from http://water.epa.gov/lawsregs/guidance/303.cfm

United States Environmental Protection Agency. (September 11, 2013). *Handbook for developing watershed plans to restore and protect our waters.* Retrieved from http://water.epa.gov/polwaste/nps/handbook_index.cfm

United States Environmental Protection Agency. (2012, October 03). *Agriculture*. Retrieved from http://water.epa.gov/polwaste/nps/agriculture.cfm

Weiss, C. *Evaluation research: Methods for assessing program effectiveness*. (1972). Englewood Cliffs, NJ: Prentice-Hall, Inc. Retrieved from http://65.182.2.242/docum/crid/Febrero2005/pdf/eng/doc345/doc345-contenido.pdf

Weinstein, S. (2009). *The complete guide to fundraising management*. Hoboken, NJ: John Wiley & Sons, Inc.

APPENDIX A

POST CARD AND COVER LETTER FOR SURVEY INSTRUMENT

PRE-NOTICE POST CARD

Texas A&M AgriLife Extension Service
Texas Water Resources Institute
2260 TAMU
College Station, TX 77845-2260

Return Service Requested

NON PROFIT ORG.
U.S. Postage
PAID
Bryan, TX
Permit No. 83

ARROYO COLORADO
Know it. Respect it. Enjoy it.
Conócelo. Respétalo. Disfrútalo.

Texas Water
Resources Institute
make every drop count

June 2013

A few days from now, you will receive in the mail a request to fill out a questionnaire for an important research project being conducted by the Texas Water Resources Institute.

Agricultural producers in Cameron, Hidalgo, and Willacy counties have had water concerns, and this questionnaire will help the Institute understand and address some of those concerns, especially related to educational programs, conservation practices, and other current programs.

I am writing in advance because we have found many people like to know ahead of time that they will be contacted. If you would like to complete this questionnaire in advance, please go to valleyevaluation.tamu.edu.

Thank you for your time and consideration. It's only with the generous help of people like you that our research can be successful.

Sincerely,
T. Allen Berthold
Project Specialist, Texas Water Resources Institute
979-845-2028, taberthold@ag.tamu.edu

SURVEY COVER LETTER – FIRST MAILING

TEXAS A&M AGRILIFE RESEARCH | EXTENSION

TEXAS A&M UNIVERSITY
AGRICULTURE & LIFE SCIENCES
TEXAS WATER RESOURCES INSTITUTE

July 2013

Greetings,

I am writing to ask your help in a study of agricultural producers in Cameron, Hidalgo, and Willacy Counties being conducted to better understand local water-related needs. This study is part of an effort to gain a better understanding of educational needs for water programs, barriers to conservation practice adoption, and current effectiveness of water programs.

We are contacting a random group of agricultural producers in the three counties to ask producers what water-related educational programs they would like to see, to identify the barriers to adopting conservation practices among producers, and to evaluate one of our programs.

Results of this study will be used to help local and state water educators deliver more relevant water-related educational programs, understand and help reduce the barriers to conservation practice adoption, and revise our efforts to be more effective. In answering these questions, we hope to improve water conditions in the Lower Rio Grande Valley by using the information from your response, not just what we think are the issues.

Your answers are completely confidential and will be released only as a summary in which no individuals' answers can be identified. When you return your completed questionnaire, your name will be deleted from the mailing list and never connected to your answers in any way. This evaluation is voluntary; however, you can help us very much by taking about 15 minutes to share your opinions about water and agriculture. If for some reason you prefer not to respond, please let us know by returning the blank questionnaire along with your name in the enclosed, pre-paid return envelope. If you prefer to complete this survey electronically, please access it at valleyevaluation.tamu.edu.

If you have any questions or comments about this evaluation, I would be happy to talk with you. My phone number is 979-845-2028 or you can mail comments to 1500 Research Parkway, Ste. 110, College Station, TX 77843-2260. Also, if you have questions related to your rights regarding this research, please contact the Institutional Review Board of Texas A&M University at 979-458-4067, or irb@tamu.edu.

Thank you very much for helping with this important study.

Sincerely,

T. Allen Berthold

Project Specialist, Texas Water Resources Institute

1500 Research Parkway, Suite 110
2260 TAMU
College Station, TX 77843-2260

Tel. 979.845.1851 Fax 979.845.0662
twri@tamu.edu

http://twri.tamu.edu

REMINDER POST CARD

Texas A&M AgriLife Extension Service
Texas Water Resources Institute
2260 TAMU
College Station, TX 77845-2260

Return Service Requested

NON PROFIT ORG.
U.S. Postage
PAID
Bryan, TX
Permit No. 83

July 2013

A couple of weeks ago, a questionnaire seeking your opinions about water-related needs in agricultural production was mailed to you. Your name was randomly chosen from a list of people related to agricultural production in Cameron, Hidalgo, and Willacy Counties.

If you have already completed and returned the questionnaire to us, please accept my sincere thanks. If not, please do so today. We are especially grateful for your help because it is only by asking people like you to share your opinions that we can understand what the water-related needs for agriculture are in the Lower Rio Grande Valley.

If you did not receive a questionnaire or it was misplaced, you can go to valleyevaluation.tamu.edu and complete the survey online or call me at 979-845-2028 and I will get another one in the mail today.

Sincerely,
T. Allen Berthold
Project Specialist, Texas Water Resources Institute
979-845-2028, taberthold@ag.tamu.edu

COVER LETTER – SECOND MAILING

TEXAS A&M AGRILIFE RESEARCH | EXTENSION

TEXAS A&M UNIVERSITY
AGRICULTURE & LIFE SCIENCES
TEXAS WATER RESOURCES INSTITUTE

July 2013

Greetings,

About four weeks ago, a questionnaire was sent to you that asked what you believe are the water-related priorities for agricultural producers in Cameron, Hidalgo, and Willacy counties. To the best of our knowledge, this questionnaire has not yet been returned.

The comments of other people who have already responded include a wide variety of answers about their priorities. We think the results are going to be very beneficial to local and state water educators and others.

I am writing again because your response is important to get accurate results. Although we sent questionnaires to people living in all three counties in the Lower Rio Grande Valley, it's only by hearing from nearly everyone that we can be sure that the results are truly representative. If you prefer to complete the survey online, please go to valleyevaluation.tamu.edu.

A few people have written to say they should not have received the questionnaire because they no longer participate in agricultural production or do not live in the respective counties. If either of these apply to you, please let us know on the cover of the questionnaire and return it in the enclosed envelope so that we can delete your name from the mailing list.

A comment on our survey procedures: We request the first few numbers in your mailing address so that we can delete your name from our list once the survey is returned. This list of names is then destroyed so that individual names can never be connected to the results in any way. Protecting the confidentiality of people's answers is very important to us.

We hope that you will fill out and return the questionnaire soon, but if for any reason you prefer not to answer it, please let us know by returning a note or blank questionnaire with your name in the enclosed envelope.

Thank you again for your time.

Sincerely,

T. Allen Berthold

Project Specialist, Texas Water Resources Institute

1500 Research Parkway, Suite 110
2260 TAMU
College Station, TX 77843-2260

Tel. 979.845.1851 Fax 979.845.0662
twri@tamu.edu

http://twri.tamu.edu

APPENDIX B

SURVEY INSTRUMENT

Agricultural Water Assessment

Do you choose to complete this evaluation?

- ○ Yes (1)
- ○ No (2)

Please provide the numbers to your street address or PO box address (CONFIDENTIAL - only used to ensure that results are not duplicated).

Of the land that you operate, about how many acres would fall under each of the following landowner categories?

_____ Self owned (1)

_____ Owned by an individual that lives in the area (2)

_____ Owned by an individual that DOES NOT live in the area (3)

_____ Owned by a public or private entity (4)

Please indicate the percentage of each cropping type that your operation consists of.

_____ Row crops - irrigated (1)

_____ Row crops - dry-land (2)

_____ Citrus or other permanent crop (3)

_____ Improved pasture/hay-land (4)

_____ Unimproved pasture/hay-land (5)

The numbers in parentheses beside the answers are for tallying survey results. Please ignore.

Please indicate your level of agreement regarding what you think are some educational needs for agricultural producers related to water.

	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Somewhat Disagree (4)	Disagree (5)	Strongly Disagree (6)
How water quality impacts your operation (1)	○	○	○	○	○	○
How agricultural production impacts water quality (2)	○	○	○	○	○	○
What current water quality levels are (e.g. nutrients, salinity, etc.) (3)	○	○	○	○	○	○
Specific conservation practices that improve water quality (4)	○	○	○	○	○	○
How you can improve your operation by adopting conservation practices (5)	○	○	○	○	○	○
Updates on conservation practices effectiveness (6)	○	○	○	○	○	○
How to install/maintain conservation practices (7)	○	○	○	○	○	○
Fertility application methods (e.g. nutrient management) (8)	○	○	○	○	○	○
Sources of financial incentives available to help pay for conservation practices (9)	○	○	○	○	○	○
Requirements of financial incentive programs (10)	○	○	○	○	○	○
How to apply for financial incentives (11)	○	○	○	○	○	○
Information about upcoming incentive programs (12)	○	○	○	○	○	○
Specific conservation practices that reduce the amount of irrigation water used (13)	○	○	○	○	○	○
How much water is needed to produce various crops (14)	○	○	○	○	○	○
Current and new irrigation technologies (15)	○	○	○	○	○	○
How much irrigation water is available for the upcoming year (16)	○	○	○	○	○	○

Optional: Please provide additional information about what you think educational needs related to water for agricultural are.

Have you adopted any water conservation practices as part of your operation?

- ○ Yes (1)
- ○ No but I intend to (2)
- ○ No and I do not intend to (3)

Have you used any of the following incentive programs?

	Yes (1)	No, but I intend to (2)	No, and I do not intend to (3)
Water Quality Management Plan (WQMP) (TSSWCB) (1)	○	○	○
Environmental Quality Incentives Program (EQIP) (USDA-NRCS) (2)	○	○	○
Conservation Reserve Program (CRP) (USDA-FSA) (3)	○	○	○
Landowner Incentive Program (LIP) (TPWD) (4)	○	○	○

Please indicate your level of agreement regarding the reasons you **HAVE NOT** adopted water conservation practices through incentive programs.

	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Somewhat Disagree (4)	Disagree (5)	Strongly Disagree (6)
Initial cost of installing (1)	○	○	○	○	○	○
Maintenance costs (2)	○	○	○	○	○	○
Incentive (cost-share) levels are too low (3)	○	○	○	○	○	○
Uncertain if practices will increase or decrease profit (4)	○	○	○	○	○	○
Eligibility of a program (5)	○	○	○	○	○	○
Lack of available cost-share funds (6)	○	○	○	○	○	○
Land does not meet the requirements of the program (7)	○	○	○	○	○	○
Terms of the contract (8)	○	○	○	○	○	○
Did not know about incentive programs (9)	○	○	○	○	○	○

Please indicate your level of agreement regarding the reasons you **HAVE NOT** adopted water conservation practices through incentive programs.

	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Somewhat Disagree (4)	Disagree (5)	Strongly Disagree (6)
Lack of information about conservation practice effectiveness (1)	○	○	○	○	○	○
Lack of opportunities to see practices at demonstrations (2)	○	○	○	○	○	○
Lack of educational opportunities about conservation practices (3)	○	○	○	○	○	○
Lack of time to implement/ maintain conservation practices (4)	○	○	○	○	○	○
Lack of labor to implement conservation practices (5)	○	○	○	○	○	○
Conservation practices are outside of methods of operating (6)	○	○	○	○	○	○
Belief that adopting practices would really make a difference in water quantity and/or quality (7)	○	○	○	○	○	○
Operation size is too large to implement practices (8)	○	○	○	○	○	○
Do not want to be tied to a government program (9)	○	○	○	○	○	○

Optional: Please provide additional information about why you have not adopted water conservation practices through incentive programs.

Please indicate your level of agreement regarding the following:

	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Somewhat Disagree (4)	Disagree (5)	Strongly Disagree (6)
Educational programs related to water and conservation practices have occurred often enough (1)	○	○	○	○	○	○
Educational programs related to water and conservation practices have been beneficial (2)	○	○	○	○	○	○
As a result of educational programs related to water and conservation practices, you have made changes to your operation (3)	○	○	○	○	○	○
Additional money has come to the Rio Grande Valley for cost-share programs in the last 5 years (4)	○	○	○	○	○	○
Cost-share programs have benefited your operation (5)	○	○	○	○	○	○
Cost-share assistance has been available when you attempted to apply through various agencies (6)	○	○	○	○	○	○
Technical assistance for conservation practices has been readily available when it was needed (7)	○	○	○	○	○	○
Technical assistance was used when installing water conservation practices (8)	○	○	○	○	○	○
You benefited from available technical assistance (9)	○	○	○	○	○	○
Monitoring results from water conservation practice effectiveness studies were made available upon completion of a project (10)	○	○	○	○	○	○
Monitoring results from water conservation practice effectiveness studies were useful (11)	○	○	○	○	○	○
Monitoring results from water conservation practice effectiveness studies made you want to change the way that you manage your operation (12)	○	○	○	○	○	○

Please indicate your level of agreement regarding the following programs that need additional focus in the Rio Grande Valley for agricultural producers.

	Strongly Agree (1)	Moderately Agree (2)	Agree (3)	Disagree (4)	Moderately Disagree (5)	Strongly Disagree (6)
Educational Programs (1)	○	○	○	○	○	○
Cost-share assistance (2)	○	○	○	○	○	○
Technical assistance (3)	○	○	○	○	○	○
Monitoring and assessment (4)	○	○	○	○	○	○

Optional: What other types of programs are needed for agricultural producers?

Have you heard of the Arroyo Colorado Watershed Protection Plan or Partnership?

○ Yes (1)

○ No (2)

Please indicate your level of agreement regarding the following:

	Strongly Agree (1)	Moderately Agree (2)	Agree (3)	Disagree (4)	Moderately Disagree (5)	Strongly Disagree (6)
The Arroyo Colorado Watershed Protection Plan has been effective in improving water quality (1)	○	○	○	○	○	○
The Arroyo Colorado Watershed Protection Plan has been effective in implementing agricultural programs (2)	○	○	○	○	○	○
The Arroyo Colorado Watershed Protection Plan has been beneficial to the Lower Rio Grande Valley (3)	○	○	○	○	○	○
The Arroyo Colorado Watershed Partnership should continue implementing agricultural programs using the same methods (4)	○	○	○	○	○	○

What age range do you fall into?

- ○ Under 18 (1)
- ○ 18 - 30 (2)
- ○ 31 - 50 (3)
- ○ 51 - 70 (4)
- ○ 71 and over (5)

What is your gender?

- ○ Male (1)
- ○ Female (2)

What is your ethnicity?

- ○ American Indian or Alaska Native (1)
- ○ Asian (2)
- ○ Black or African American (3)
- ○ Native Hawaiian or Pacific Islander (4)
- ○ Spanish, Hispanic, Latino (5)
- ○ White (6)

What is the highest level of education you have completed?

- ○ Less than High School (1)
- ○ High School Diploma (2)
- ○ Some College (3)
- ○ Bachelors Degree (4)
- ○ Post-Graduate Degree (5)

Please provide your email if you would like to be added to the mailing list to receive updates about Arroyo Colorado Partnership Activities.

APPENDIX C

RESPONSES TO OPEN-ENDED QUESTIONS

Optional: Please provide additional information about what you think educational needs related to water for agriculture are.

I disagree in principle with subsidies and incentives and cost-sharing. Others should not have to pay through taxation for my livelihood.
Make the general public more aware just how much their existence depends on agriculture
The main concern that I have noticed is how water districts have deviated from previous established practices. In my area, resacas used to be kept full and flowing to filter out salty sediments thereby keeping the available irrigation water quality high. Recently resacas are allowed to virtually dry up and whatever water is left becomes salty and of no use for irrigation. I have seen crops destroyed because they were irrigated with very poor quality water. All aquatic forage has disappeared as has most fish life. I see this as a very poor practice. Once this happens it takes years to restore the quality to pre previous levels. Because this is allowed to happen we require additional chemicals to neutralize the salt.
Economic viability of conservation practices
Education to farmers about how to install, maintain and cost effectiveness of water wells to be used for irrigation purposes is needed!
Use of drip irrigation for more than one crop
Do people want to eat? (if you want to eat you're involved in agriculture)? Environmental management should be based on science. For too many environmentalists in their religions. They went to put curbs on everyone else and respect them to pay for their schemes but environmentalist continue their on polluting activities.
Public education of the difference in municipal water from Ag water.
Did not think I can answer other questions because the land is leased and I do not do the farming
this is dry land
I'm am not educated in this matter to have an opinion
Need to know how to determine optimum use of water. Overuse or flooding can retard or reduce yield and leach fertilizer elements.
water wells cost studies and water table government subsidies desalination, deep water wells, improvement of dry land farming techniques
we need to mobilize the politicians to get Mexico to come current on their water debt
more info to all farmers so we can understand
We are dryland farmers
It is in a producer's best interest to keep informed of best practices when it comes to water usage. I am concerned about incentive programs that are so complex that only big operators and the politically connected will be able to be approved for such programs. I am also suspicious of the strings that come with such "government help" programs whether or not producers will be compelled to obey government edicts or lose their land. Education about water use and conservation should be voluntary...
no opinion
A way for producers to petition the government to change the water treaty with Mexico. A way for farmers to unite on this water issue.
water is life
how growing organically without synthetic fertilizers can reduce the impact on the runoff water
Rio Grande Valley Ag Producers need to educate State & Federal State Dept. officials on how to negotiate 1944 Treaty Water Compliance with their Mexican counterparts.

Optional: Please provide additional information about why you have not adopted water conservation practices through incentive programs.

Lack of financial assistance and no support from irrigation district to conserve water (water meters). Irrigation not by acre-ft of water, instead irrigation by surface acre, no incentive to conserve water usage, & water drained from fields, excessive application
I am very interested in receiving information on what programs are available for the implementation and adoption of water conservation through incentive programs.
Not aware
My 20 acres are non-irrigated, unimproved pasture /hay-land
Do people want to eat? (if you want to eat, get involved in agriculture)?. Environmental management should be based on science. For too many environmentalists it's their religion. They want to put curbs on everyone else and expect them to pay for their schemes, but environmentalists continue their own polluting activities!
have not seen any material on this
was not aware of such programs
lack of information
unaware
Need coordinated planning to work in time to put in place the land leveling, or the practice called for and still maintain support for land lords. The last few years I have not utilized the services on the following page because I lack the energy and cooperation of the tenant.
too expensive
I was not aware of any incentive programs
highway department practices greatly overshadow and negate a farmer's conservation/quality efforts
We need a drainage ditch in Willacy County (La Sara area) Land is salting out due to lack of --
applied practices under 503 & 319 program
my property is ranch land, I do not irrigate
I do not farm. Dry and rancher cost-maintenance cost-labor-paperwork
really don’t know about any of the programs
did not know much about them
I have adopted all water conservation practices that I know of which fit my farming operation
Because our great governor gave our water away to New Mexico
severe drought
Government money for insiders (those who can afford lawyers) only!
dry land
I'm retired and take care of only 20.5 acres of citrus
Amount of money paid for taxes (property, school, and water) takes most, if not all, of what can be charged for rent or lease, thus funds will not be financially practical
Because i do not know of any that are available. If I have adopted any it is because of what I have read in publications, ie magazines
I practice water conservation practices
Startup cost out of reach. To install "drip system" would take away too much from operating budget.

Primary: do not know what is available
Two Main reasons farmers do not adopt water savings equipment & techniques are high cost and the fact that irrigation districts penalize you for using water savings methods because their delivery systems are very inefficient.

Optional: What other types of programs are needed for agricultural producers?

Improved delivery systems
1. Programs that instruct farmers on innovative uses of current irrigation water 2) Programs that teach how to install water wells for irrigation 3) Programs that assist with funding of water well installation
Information on practical methods that work and are cost effective. Procedures need to be technologically feasible and implementable, not theoretical or dreams.
any and all that can help us in S Texas
I have been to the federal, state, and local offices concerning ways to get water/ conserve water. no time or money for me
retains programs related to invasive species
Mailings to my PO Box, info about programs, not emailing me. Thanks.
operational finance assistance
How about ones that are for everyone and not just those that are connected or minorities
We are dryland farmers. May be different opinions on what can be planted during drought years.
More drainage ditches in Willacy County
Additional networking
Possibly have workshops mentioned above during evening hours. This will allow people that work during the day to attend these workshops or programs
more monitoring of sugarcane irrigation as I believe this industry has depleted Falcon Lake water greatly
Current input process and estimated future prices. Fertilizer - fuel - seed
conservation in general
Improve what we have
Producers and/or irrigation districts need to (mandatory) meter their water usage; producers are wasting too much irrigation water especially on crops like sugarcane.
Anything that will help farmers cope drought and rising costs. I am somewhat new to this, and perhaps no the best at answering.

APPENDIX D

IRB EXEMPTION LETTER

DIVISION OF RESEARCH

Office of Research Compliance and Biosafety

TEXAS A&M UNIVERSITY

APPROVAL DATE:	05/02/2013
MEMORANDUM	
TO:	Jeffrey Ripley TAMU - College Of Agriculture - Ag Leadership, Education & Communication
FROM:	Dr. James Fluckey Chair Institutional Review Board
SUBJECT:	Initial Review Approval

Protocol Number:	IRB2013-0208
Title:	Addressing Water Quality Mitigation Challenges Through Evaluation
Review Type:	Exempt
Approved:	05/02/2013
Continuing Review Due:	03/15/2016
Expiration Date:	04/30/2016
Review Categories and Regulatory Determinations:	Exempt Approval 45 CFR 46.101(b)(2): Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.
Documentation of Consent:	Waiver approved under 45 CFR 46.117 (c) 1 or 2/ 21 CFR 56.109 (c)1

Provisions:

Comments:

This research project has been approved. As principal investigator, you assume the following responsibilities

1. Continuing Review: The protocol must be renewed by the expiration date in order to continue with the research project. A Continuing Review application along with required documents must be submitted by the continuing review deadline. Failure to do so may result in processing delays, study termination, and/or loss of funding.
2. Completion Report: Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB.
3. Unanticipated Problems and Adverse Events: Unanticipated problems and adverse events must be reported to the IRB immediately.

750 Agronomy Road, Suite 2701
1186 TAMU
College Station, TX 77843-1186

Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu

4. Reports of Potential Non-compliance: Potential non-compliance, including deviations from protocol and violations, must be reported to the IRB office immediately.
5. Amendments: Changes to the protocol must be requested by submitting an Amendment to the IRB for review. The Amendment must be approved by the IRB before being implemented.
6. Consent Forms: When using a consent form or information sheet, you must use the IRB stamped approved version. Please log into iRIS to download your stamped approved version of the consenting instruments. If you are unable to locate the stamped version in iRIS, please contact the office.
7. Audit: Your protocol may be subject to audit by the Human Subjects Post Approval Monitor. During the life of the study please review and document study progress using the PI self-assessment found on the RCB website as a method of preparation for the potential audit. Investigators are responsible for maintaining complete and accurate study records and making them available for inspection. Investigators are encouraged to request a pre-initiation site visit with the Post Approval Monitor. These visits are designed to help ensure that all necessary documents are approved and in order prior to initiating the study and to help investigators maintain compliance.
8. Recruitment: All approved recruitment materials will be stamped electronically by the HSPP staff and available for download from iRIS. These IRB-stamped approved documents from iRIS must be used for recruitment. For materials that are distributed to potential participants electronically and for which you can only feasibly use the approved text rather than the stamped document, the study's IRB Protocol number, approval date, and expiration dates must be included in the following format: TAMU IRB#20XX-XXXX Approved: XX/XX/XXXX Expiration Date: XX/XX/XXXX.

The Office of Research Compliance and Biosafety is conducting a brief survey for the purpose of programmatic enhancements. Click here to take survey or copy and paste in a browser
https://tamu.qualtrics.com/SE/?SID=SV_1CgOkLNU45QebvT

This electronic document provides notification of the review results by the Institutional Review Board.