Impacts of Institutions on Water Conservation Incentives in the Texas Rio Grande Valley

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Texas Water Resources Institute
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Texas A&M AgriLife Office of Federal Relations

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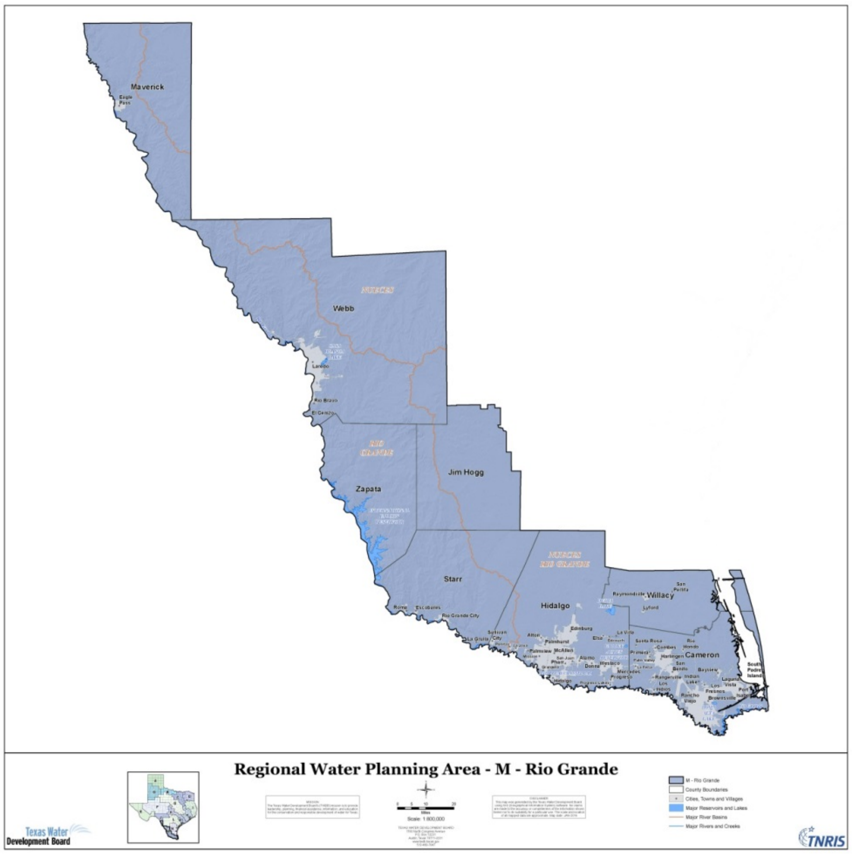

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ABSTRACT

The Texas Lower Rio Grande Valley is a large agricultural region with limited water resources. With rapid expansion in population and industrial growth, there is an increasing competition for water, particularly in times of drought or due to under deliveries of water by Mexico. This competition is further aggravated by expected global climate change and outlook for reduced rainfall and higher temperatures. To address the issue of limited water supply, a major initiative is to accelerate conservation by cities, irrigation districts, and industry and on farms. Progress has been significant for cities and irrigation districts but less so on farms.

After years of court cases and state decisions, the majority of Rio Grande surface water rights in the region are held by irrigation districts. Therefore, there is little incentive for farmers to make investments in equipment or management to conserve water since any savings reverts to the irrigation districts. This paper is a review of the evolution of irrigation in South Texas, the process for establishing water rights and the implications for on-farm water conservation. A set of on-farm water conservation alternatives is presented with insight on water savings and economic implications followed by potential strategies to provide incentives to farmers to implement water conservation on-farm and how the region as a whole benefits.

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Introduction

The Adam Smith description of people following the "invisible hand" in decision-making still stands; it takes incentives to get a desired action. This paper addresses the issue of irrigated agriculture in the Texas Rio Grande Valley where typically the water is pumped from the Rio Grande. Given issues of drought, international border, and increasing demand for water, conservation is heralded as low hanging fruit. Certainly water conservation applies to those supplying the water (irrigation districts) and farmers that use the water for irrigation. To put agriculture water conservation into perspective, a description of the evolution of irrigation in this region, how water rights were established, and the role of irrigation districts are presented. The focus is on-farm water conservation from the perspective of the farmer.

Description of the Region

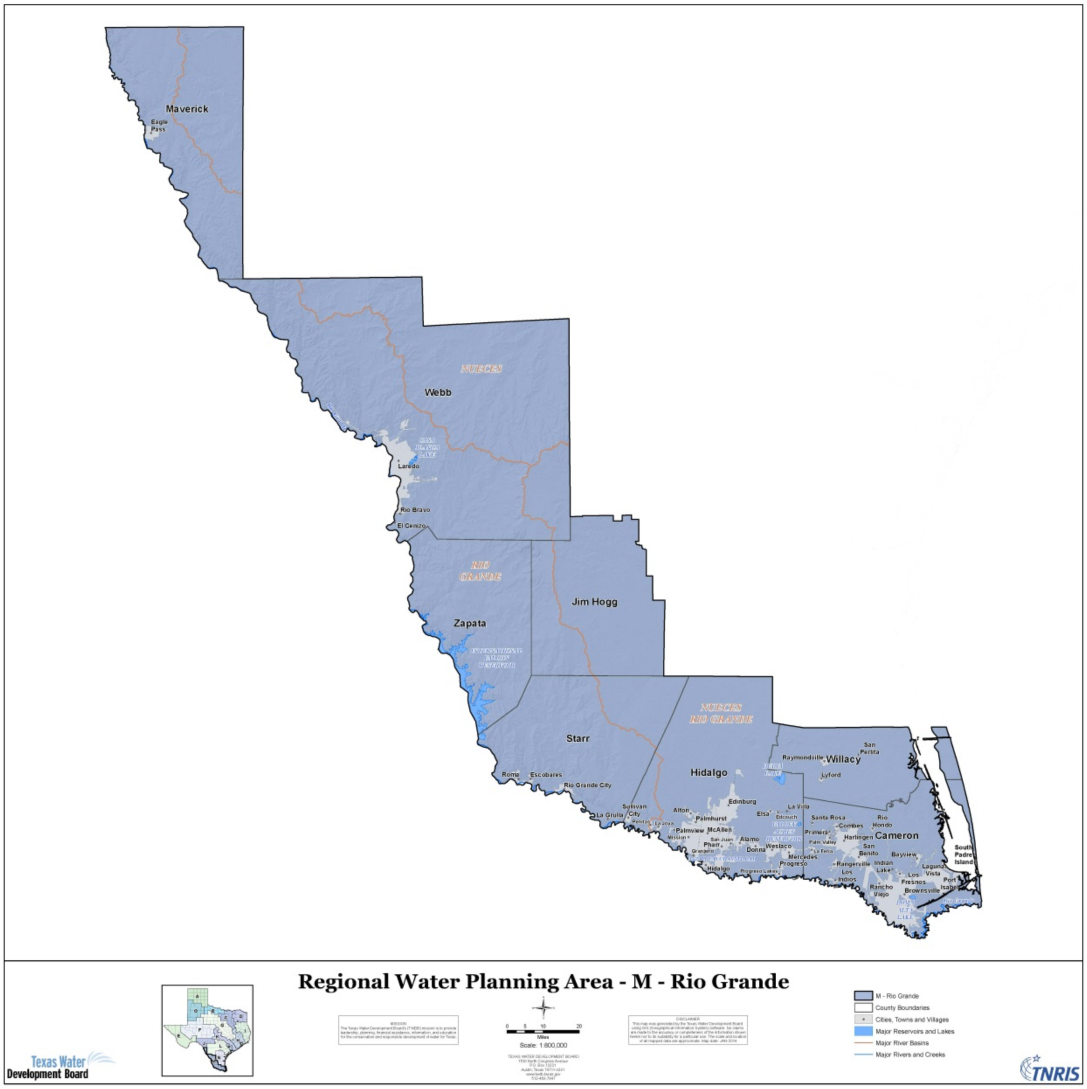
The Lower Rio Grande Valley in South Texas is a tropical environment with a long growing season, making it a highly productive agricultural region. Although crops can be grown dryland or rain fed, irrigation increases the diversity of crops dramatically and provides incentive for high value crops. The region has seen a significant population increase, which places pressure on resources, particularly water, of which the Rio Grande is the principal source. Historical background and how the area developed provide an appreciation for the current situation.

Region

The Lower Rio Grande Valley (LRGV) contains eight counties; Maverick, Webb, Zapata, Jim Hogg, Starr, Hidalgo, Cameron, and Willacy, and represents the Southern-most point in Texas (see Figure I). Willacy and Cameron are the only two counties of the LRGV that share a border with the Gulf of Mexico while Jim Hogg and Willacy are the only counties that do not share a border with the Rio Grande (Texas Water Development Board, 2015).

History

A brief history is useful to better understand the make-up of the region. Agriculture, the main user of water, did not begin in the area until after 1740 with Mexican and Spanish ranch settlements. Until this time, visitors to the Valley deemed it too difficult to settle without expansive irrigation (Teja). After the Mexican-American War in the mid-1800s, the region became largely unpopulated. In the 1890s, land developers began digging irrigation canals and removing brush and other vegetation, thereby transforming the landscape into an "agricultural oasis" (Dillman). When the 1920s arrived, the Valley was in a full agricultural boom. With an unlimited supply of cheap labor from Mexico and the St. Louis, Brownsville, and Mexico Railway company (SLB&M) taking commodities to the urban centers, the recipe for aggressive expansion was in place. This population explosion brought with it many things, including some serious issues concerning the water supply and the issues between municipalities and irrigation networks established by the farmers.



Source: Texas Water Development Board, 2015

Figure 1: The Lower Rio Grande Valley: Texas

Current Population

The current population of the LRGV in Texas, or colloquially known as *the* Valley, is 1.26 million people and is projected to increase to 3.05 million by 2050 (Texas Water Development Board, 2015). Certain counties, such as Hidalgo County, are experiencing massive sustained growth rates. According to the U.S. Census Bureau, the county has grown 7.3% between April 1, 2010 and July 1, 2014, which is more than double the national average (U.S. Bureau of the Census). With a highly productive agricultural sector that largely depends on irrigation and the rapidly expanding growth in cities as well as industry, the issues related to allocation of a limited resource are of paramount importance. A major option is water conservation and incentives for adopting conservation measures and the focus of this paper, on-farm water conservation and farmer based incentives.

Water Delivery

The most current water diplomacy between the U.S. and Mexico was established in the Water Treaty of 1944. It created the International Boundary and Water Commission, an international body consisting of U.S. and Mexican Sections, which are overseen by the U.S. State Department and the Mexico Ministry of Foreign Relations, respectively (Carter, Seelke, and Shedd). The U.S. and Mexico share the Rio Grande and Colorado River. The U.S. supplies water to Mexico from the Colorado River basin as well as the Rio Grande at El Paso. The U.S. receives water from Mexico in the Rio Grande Valley from Fort Quitman, Texas to the Gulf of Mexico. According to this treaty, Mexico agreed to supply a minimum of 350,000 ac.-ft. per year to the U.S. from the Rio Conchos Basin and other small tributaries that feed the Rio Grande (Stubbs, et al. 2003). The U.S. agreed to supply 1.5 million ac.-ft. to Mexico via the Colorado River. The delivery system with Mexico is monitored in 5-year cycles. Mexico honored the deliveries until the 1994-2003 droughts. Mexico acquired a water debt through two cycles. They were able to pay this back with the help of hurricane-induced wet conditions in 2005 (Carter, Seelke, and Shedd).

The current delivery cycle started on October 25, 2010 and is expected to end October 24, 2015. In October 2014, at the end of the fourth year in a 5-year cycle, Mexico was 339,495 ac.-ft. behind in deliveries, based on total delivery obligations in that 4-year time of 1.4 million ac.-ft. A significant cause for the shortages in deliveries was the intense periods of drought experienced in the second year of the cycle. Mexico attempted to correct this by over allocating in the third year, though available estimates indicated that Mexico was short again in the fourth year. The U.S. does not go without fault. In the Northwestern Rio Grande Basin, which is the El-Paso/Ciudad Juarez area, the U.S. has been short on deliveries to Mexico also. In 2013, the U.S. only delivered 6% of its entire allotment; subpar deliveries also occurred in 2012 and 2014 (Carter, Seelke, and Shedd).

Crops

The main water user in the area is agriculture, although domestic, municipal, and industrial use is increasing at an exponential rate. Presented in Table 1 is a summary of average annual irrigated crop acreage and water demand for the Rio Grande Water Planning Region M over the period 2003 until 2007 (Texas Water Development Board, 2015). Grains comprise the greatest acreage but in some cases are not irrigated. Total cropped acres were 459,000 of which 253,000 are irrigated. (Values in Table 1 may not add due to rounding error.) The sugarcane, although not so many acres (42,000), is a high water user, taking approximately 142,000 ac.-ft. Vegetables and cotton are large acreage crops. The gross value per acre is greatest for vegetables and fruits at over $6,000 with tree nuts over $3,000 and sugarcane over $1,000. The total water demand for irrigation for the Lower Rio Grande Valley is an estimated 937,000 ac.-.ft. Over one-fourth goes to grains and all other crops, respectively. Table 2 provides a description of what is included in each of the crop categories. The reader is referred to the Texas Water Development Board, Regional Water Plans for the latest estimates since Texas water planning is an on-going effort.

It is the irrigated crops where there is opportunity to install and adopt irrigation conserving technologies and management strategies. If farmers are to adopt these conservation strategies, they need the confidence that their expected profits will be protected.

Table 1: Irrigated crop acres and water use in the Lower Rio Grande Valley of Texas: average for 2003-07.

Sector	Acres (1000s)	Gross Revenue per acre	Water Use (1000s of ac-ft.)	Distribution of water use
Oilseeds	4	$214.00	5	1%
Grains	143	$267.00	253	27%
Vegetable and melons	73	$6,246.00	120	13%
Tree Nuts	7	$3,304.00	18	2%
Fruits	13	$6,305.00	34	4%
Cotton	59	$389.00	111	12%
Sugarcane	42	$1,051.00	142	15%
All other crops	120	$254.00	252	27%
Total	459		937	100%

Source: Texas Water Development Board, Region M Summary 2015

Table 2: Description of crops included in each of the categories.

IMPLAN Category	TWDB Category
Oilseeds	Soybeans and "other oil crops"
Grains	Grain sorghum, corn, wheat and "other grain crops"
Vegetable and melons	"Vegetables" and potatoes
Tree nuts	Pecans
Fruits	Citrus, vineyard, and other orchards
Cotton	Cotton
Sugarcane and sugar beets	Sugarcane and sugar beets
All "other" crops	"Forage crops," peanuts, alfalfa, hay and pasture, rice and "all other crops"

Source: Texas Water Development Board, Region M Summary 2015

Establishment of Water Rights

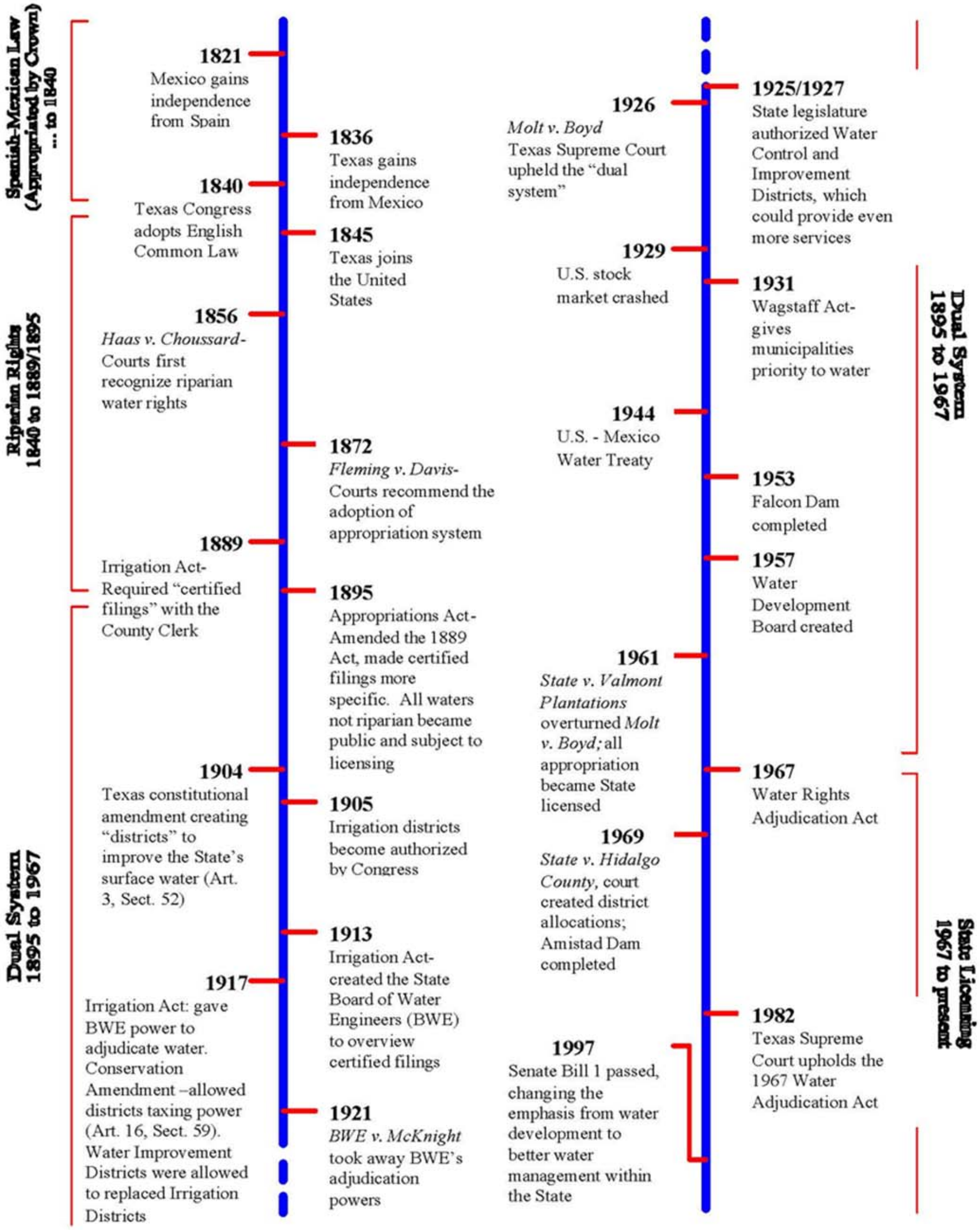
The goal of this section is to explain the complicated water rights system for the Valley. Since becoming a state, Texas has used three different systems of water law: riparian (1840-1889), the "dual system" (1889-1967), and state licensing (1967-present). The change in systems was a result of numerous legal cases and adjudication. Refer to *Figure 2* for a timeline of water rights legislation (Baade; Kaiser; Smith; Stambaugh and Stambaugh; and State of Texas). The first system used in Texas was the Spanish/Mexican system, which was riparian. Riparian water law allows landowners adjacent to surface water the rights to that water. For example, if your land was next to a large natural lake, you are the lawful owner of those surface water rights and you can "make reasonable use of water for irrigation or for other purposes" (Templer). In the 1872 case of *Fleming v. Davis,* the courts recommendation was to adopt an appropriation system on top of the old system (Baade). During this stretch, Texas had what Baade called a "dual system." The main issue with this system is it led to gross over-appropriation of water. In order to get water rights under this dual system, water users had to file an affidavit with the county clerk. These affidavits were considered "certified filings" and issued on a first-come, first serve basis (Stubbs, et al. 2003).

The issue of over appropriation was addressed with the passing of the 1913 Irrigation Act. Under the 1913 act, the state created the Texas Board of Water Engineers (TBWE) as well as introducing statutes to present a formal process for established water rights. In 1917, the TBWE was given the right to adjudicate water rights. This meant that all state-owned surface water had to be appropriated through permits. This right and power was then taken away by the Texas Supreme Court in the case *State Board of Water Engineers v. McKnight* (111 Tex. 82; 1921). The Court ruled that it was unconstitutional for an executive agency to perform judicial duties. The Supreme Court, however, upheld the dual system in *Molt v. Boyd* (116 Tex. 82; 1926) by continuing to allow riparian water rights to coexist with appropriation rights (Baade).

The dual system issue was not completely resolved until the 1950s when the building of the Falcon Reservoir began (Templer). The courts decided to look again at Spanish/Mexican law, which up until this time was completely riparian. In the case *State v. Valmont Plantations* (346 S.W.2d 853; 1961), it was decided that all Spanish and Mexican grants resulting from transferring public property to private ownership had to emanate from the Crown, including water rights (Teja). What that means is that the Spanish/Mexican irrigation system in existence in trans-Nueces Texas (area between Nueces and Rio Grande rivers) was not riparian in nature (Baade). Texas had moved away from the dual system to a single state licensing system for surface water rights.

Another fundamental aspect that is impacting water rights and allocation is the effect of the landmark lawsuit, *State of Texas v. Hidalgo county Water Control and Improvement District No. 18* (1969), commonly called the "Lower Rio Grande Valley Suit" (Stubbs et al. 2003). This was a very long and expensive lawsuit; it took almost 15 years from filing to decision and involved 2,500 individuals. This lawsuit designated several different categories of water rights.

Figure 2: History of the Development of Texas Water Law as it Pertains to the Lower Rio Grande Valley (1821 – 1997)



Source: Baade; Kaiser; Smith; State of Texas; Stambaugh and Stambaugh

The domestic, municipal, and industrial (DMI) rights have the highest priority for allocation. Following that, there are two classes of irrigation water rights: Class A and Class B. Class A water rights were designated to individuals or institutions that had a proven water right such as Spanish-Mexican grant or a prior appropriation. Class B rights were designated for individuals or institutions that could prove a "history of diversion" from the Rio Grande (Stubbs, et al. 2003). The difference in Class A and Class B is only apparent in times of a water shortage. Class A rights accrue water in storage at a rate of 1.7 times greater than Class B (Stubbs et al. 2003). The adjudication process occurred in a period where water availability was greater than normal, hence water was over adjudicated. This creates another set of issues but to help balance long-term availability with rights, when agricultural water is converted to municipal and industrial, it takes 1.5 ac.-ft. of agriculture water for each 1.0 ac.-ft. of municipal and industrial water.

Water Conservation Incentives

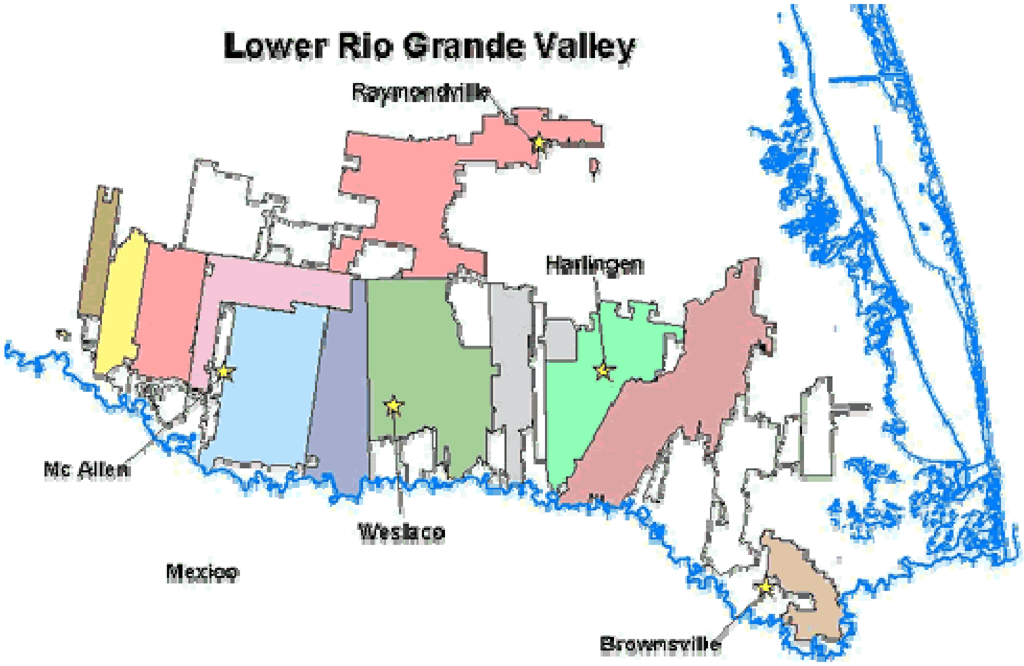
In the southern part of the Rio Grande, there are 28 irrigation districts plus one in Laredo. This indicates 29 ways of doing business with individual rules and operating procedures. Presented in *Figure 3* are the 28 irrigation districts at the tip of Texas (Texas Water Development Board, 2010). As noted earlier, the basic water rights reside with the irrigation districts. If farmers want access to this water, they have to pay a per acre charge, typically $12. However, any water savings by the farmer would in turn accrue to the irrigation district. This suggests a disincentive to farmer investment in water saving equipment, delivery system or management that has a cost associated without a clear benefit. However, across the region, there is clearly a benefit of on-farm water conservation, especially during drought or other times of water shortage.

In addition, there is the universal issue of a non-resident landowner. For the farmer renting or leasing cropland, making an investment in the land becomes problematic. This suggests the need for either a long-term lease or rental agreement so the farmer receives a return or the landowner makes the investment. For the landowner, this is an educational challenge requiring an analysis demonstrating clearly the return on investment over time. However, for the farmer or the landowner, there is the issue of where the water rights reside and who benefits from on-farm water-conserving technologies and strategies. In the most basic form and simplest interpretation, any water saved on-farm is available to the Irrigation district. The issue for the owner-operator, renter, or landowner is developing an incentive for investment to conserve water.

On-Farm Water Conservation

Clearly a case can be made for an Irrigation district to invest in water-conserving technologies and strategies since they have the right to the saved water. Typical strategies for irrigation districts include lining of earthen canals, installing pipelines, installing a SCADA system for improved management of water deliveries, expanding surface storage to capture flood flow, installing more efficient pumps, and using meters for better information of what water goes where. There are even opportunities for irrigation districts to cooperate with cross channels to avoid a water fill over two sets of distribution

Figure 3: Irrigation districts located in the Lower Rio Grande Valley of Texas



Source: Texas Water Development Board, 2015

canals for limited users at the bottom of a district. The irrigation district managers are well aware of opportunities and are very active in implementing as funds are available. There are the highly innovative irrigation districts and others less motivated. The irrigation districts' opportunities with potential water saved is discussed in depth in the Region M Texas Water Plan (Texas Water Development Board, 2015)

On-Farm Alternatives

Several on-farm technologies can lead to significant water conservation. Some are in place in the Valley, but across other regions, installations have been significant. For those using groundwater, there is an incentive for efficiency since the cost to pump water several hundred feet is very expensive. There is a strong desire to not waste energy or water for these cases. Due to the issue of water rights being held by irrigation districts, the benefits of t water conservation are more difficult to express to the Rio Grande Valley farmer. For the Region M water planning activity, there is discussion of on-farm alternatives with potential economic implications and water use impacts (Texas Water Development Board, 2015)).

Narrow Border citrus irrigation

Narrow Border irrigation of citrus can save one-third the water used by traditional flood irrigation with negligible investment in equipment yet with higher yields of better quality, substantially enhancing net farm cash income (Young, et. al.). The Texas Project for Ag Water Efficiency suggests that if this method was uniformly applied across South Texas citrus groves, the area could save up to 49,000 ac.-ft. of water a year. The Net Cash Farm Income (NCFI) for narrow border was $1,730, which is double the traditional flooding system. The total cash cost to implement narrow border irrigation is $2,000, which is also cheaper than flooding of a grove. To give an idea of the future benefit, the cumulative 10-year cash flow per acre for an average pack-out schedule would be $18,960 compared to large pan flooding at $9,030. Refer to *Figure 4* for an example of narrow border irrigation of citrus.

Figure 4: Example of Narrow Border Flooding

Source: Nelson, Texas A&M-Kingsville

Drip (on-farm storage required)

Drip irrigation is most productive when used on high value citrus (Wilbourn). In this region, it requires the installation of some form of on-farm water storage, which is a cost to the farmer. Research and demonstrations of drip irrigation suggest sugar cane yield increase of nearly 40%, onions a 20% increase and improved quality of product compared to narrow border flood irrigation. Water savings with drip compared to flood irrigation ranged from 53% on onions to 20% on citrus. Field crop studies suggest a 20% water savings of drip compared to flood or gravity flow. Nevertheless, the expensive investment did not always result in an economic advantage. Achieving a market window and high price as well as improved quality holds promise for fruits and vegetables. A drip system can be on the surface or buried (Wilbourn). Micro jet can be compared to drip irrigation and is typically used for fruit trees in major agriculture settings. Rather than an emitter in the line that drips water, with micro jet there is a small sprinkler in the surface line, which runs down a row of trees and sprays water either at the base of a tree or a 360-degree spray.

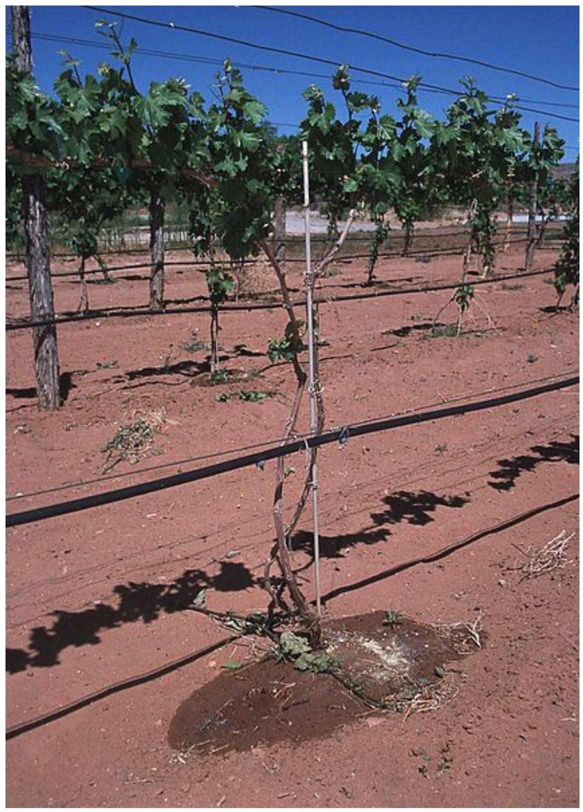


Figure 5: Example of Drip Irrigation

Source:
http://photogallery.nrcs.usda.gov/index.asp

Lining on-farm canals

The practice of lining Irrigation district canals applies as well to the irrigation ditches on a farm. A 2013 summary report for the LRGV estimated that adoption of lining across all irrigation districts would save over 100,000 ac.-ft. annually (Sturdivant, Rister, and Lacewell). This estimate is based on field studies with engineers (Fipps). With annual irrigation water of approximately one million ac.-ft., this suggests a 10% savings. Extrapolating suggests that lining ditches on farms could save as much as 10% of the on-farm water used for irrigation. The issue is open ditches allow percolation of water that is lost and not applicable for pushing water across a field. For the sample of irrigation districts, the cost per ac.-ft. of water saved ranged from $20.51 to $49.47 based on a 20-year life expectancy. In evaluating water sources, this is a very inexpensive way to expand a fixed water supply.

Figure 6: Example of Lined Canal

Installing pipelines from irrigation district to farm

The value of lining canals for an irrigation district also applies to installing pipelines on-farm to connect to the irrigation district's main canal in order to distribute water across a farm. Although more expensive, the pipeline option reduces evaporation and to some extent liability of open water. With installation of on-farm pipelines, the water savings would be more than for lining open ditches. The estimated costs per ac.-ft. of water conserved with a pipeline compared to earthen ditch ranged from $12 to $427. Most were over $90 per ac.-ft. of water saved. Cost of installing a pipeline on farm is expected to be greater than lining a ditch, perhaps about $35 per ac.-ft. of water saved for lining a ditch compared to over $100 for a pipeline installation (Sturdivant, Rister, and Lacewell).

According to a report done for the United Irrigation District of Hidalgo County, water savings with pipelines can be as high as 99% meaning only 1% loss in the distribution of water (Lee and Fipps). Earthen canals have losses in percolation as well as evaporation. In sandy soils the losses on the sides and bottom of the canal can be dramatic. This figure is related to an irrigation district canal but has relevance to the farm. A major benefit relates to water losses from an open earthen canal. For the Sturdivant, Rister, and Lacewell report, the estimates were based on analysis of irrigation districts.

Figure 7: Example of underground pipe

Source: http://academic.evergreen.edu/g/grossmaz/SUPPESBJ/

Sprinkler systems

Sprinkler systems offer an opportunity to conserve water and to irrigate fields that are rolling. Sprinkler irrigation can range from the large systems that cover a section or more of land in one rotation to smaller side-roll systems. Typically a sprinkler system is designed for field crops such as cotton, corn, sorghum and potatoes and not so much for citrus or sugarcane. There are many configurations, from a high pressure system (mostly not used at this time), to LEPA (low energy precision application) systems where water is applied to each row or every other row near the surface. This reduces evaporation and, coupled with field measures such as row dams, approaches over 95% distribution efficiency. There are several sprinkler irrigation systems in South Texas. An issue is having available water, somewhat like drip. There must be water available over several days while the system moves across a field. Over much of Texas and the U.S., sprinkler systems have been widely adopted as opposed to gravity flow or flood irrigation. It has significant labor savings and convenience factors, but the initial investment is significant.

Figure 8: Center pivot irrigation on cotton field

Polypipe/gated pipe

Polypipe and/or gated pipe serve the same efficiency as lining a ditch or installing a pipeline on-farm. Polypipe and gated pipe are put in place as needed and are on the surface. Polypipe, as the name suggests, is a plastic-type material that can be rolled up for moving or storing. Gated pipe is typically aluminum and requires a trailer or other methods for moving. Irrigation using polypipe or gated pipe is furrow or gravity flow, suggesting the conservation is derived from reduced percolation and evaporation compared to an open earthen ditch. Demonstrations showed a savings in labor and water usage with these systems compared to open ditches (Texas Water Development Board, 2010).

Figure 9: Example of Polypipe

Source: www.usgr.com

Surge Flow:

Surge flow is a technique whereby water is put through a system (such as polypipe or gated pipe) in intervals or surges. This has been used on many crops, and with high-level management of the timing of the surges, water consumption is reduced significantly (Texas Water Development Board, 2010). Although water conservation is evident, the labor and management required offer serious constraints to adopting this technique plus there is an increased possibility of polypipe rupturing due to rapid increase in flow. To gain insight on surge flow irrigation, one could imagine the polypipe in Figure 9 but rather than a steady stream, the water comes in surges.

Laser Leveling:

Laser leveling fields is a major best management technology for South Texas and contributes to irrigation water conservation. Typically a field is developed with a slope so water will flow from the distribution system to the bottom. As a practice, laser leveling is widely adopted, particularly for vegetables, fruits, and sugarcane but also for field crops such as cotton, sorghum, and corn. Laser leveling of fields is included in this report due to it being an important strategy for irrigation and water conservation. The benefits of laser leveling a field are satisfactory enough for farmers to install regardless of water rights issues.

Figure 10: Example of Laser Leveling

Source: http://luirig.altervista.org/flora/taxa/floraspecie.php?genere=Laser

Cases of On-Farm Water Conservation Adoption

Even though a case can be made that there are a lack of incentives for farmers to adopt water-conserving technologies, there are many reasons and cases for adoption of water conservation on-farm across the LRGV. Farmers are economic decision makers and their goal is not to waste water but to be economically efficient (make a profit). This section covers a few of the examples where water conservation strategies are in place on irrigated farms in the region.

High Value Vegetables

To insure germination and rapid growth, many of the vegetables in the region are grown with drip irrigation and often under plastic. This is a major investment but the risk not to do this is not wise. With drip and plastic, the growers can have greater assurance of a quality product as well as target marketing windows known through time to provide a strong price.

Citrus Technologies

With citrus being high value and perennial in nature, farmers have installed drip irrigation during establishment of groves to get the grove off to a good start. To have a drip system, as discussed earlier, most farms have to have on-farm water storage due to the daily operation of the system. It is very expensive, in terms of water and costs, to keep an irrigation canal charged for drip systems. Although expensive, the bottom line justifies the expense of drip and on-farm storage for many farmers.

Yield and Quality of Product

As with vegetables above, the same justification holds for many other agricultural crops. There is risk avoidance by adopting technologies and strategies that provide greater probability of a strong yield and improved quality. Furthermore, there is a strong incentive to plan for marketing windows, which provide higher prices for produce as mentioned above.

Laser Leveling Land

For decades the Lower Rio Grande Valley farmers have laser-leveled fields for many reasons, including the yield and quality implications stated above. The value of laser leveling includes the potential to spread the water more evenly across a field effectively providing for high and uniform yields and quality of product. Periodically, field work is required to maintain the appropriate slope.

Land Availability

There are a few cases where a farmer has land that is farmed dryland. This provides an excellent opportunity to invest in water-conserving technologies and strategies so that water saved can be used to convert dryland to irrigation. The difference in farmer returns between irrigated and dryland are dramatic, plus with irrigation there is much more consistency in yield and quality of product. In fact, it offers the opportunity for a cropping pattern comprised of the higher value crops. Typically, extra land not irrigated is uncommon for farmers in this region.

Water Supply Risk

With drought, the increasing demand for water by municipal and industrial and under-deliveries from Mexico, agriculture has felt the brunt of limited water in the past. This limitation led many farmers to explore opportunities to stretch their water and/or be able to apply more per acre. Water conservation strategies included drip, sprinkler, lined on-farm canals, laser leveling, polypipe, surge irrigation, and others. The technologies and strategies served as a form of insurance in the face of limited supplies. The same justification applies to those farmers with Class B water rights: the threat of very limited water availability.

Irrigation Scheduling

This strategy is based on crop need with the goal of not over irrigating while being prepared to apply water to avoid crop stress that impacts profitability. Applying irrigation scheduling requires information on water, crop condition, and evapotranspiration. In addition, there is a water availability issue since once irrigation water is ordered, it takes several days for it to reach the irrigation district and the famers' land. To implement irrigation scheduling suggests having a canal charged or on-farmer storage.

Potential Strategies

With the water rights system in the LRGV, often there is little to no economic incentive for farmers to investment in water-conserving technologies. However, from a regional perspective, water savings is a huge incentive to have improved water conservation on-farm. The potential solution is a method or agreement whereby those who benefit from on-farm water conservation provide incentives to farmers to make that investment.

Cost Share

A farmer can apply for financial aid from the Environmental Quality Incentives Program and/or other conservation funding from the USDA Natural Resources Conservation Service or other federal agencies to line or install a pipeline to replace an earthen ditch. With a cost share program, the government pays a part of the cost and the recipient pays a part. This can be extended to include a partnership between the irrigation district and the famer where the district pays the share not covered by the government. In this case, typically the irrigation district assumes ownership and maintenance of the on-farm facility. Some of the irrigation districts are active in this arrangement, which provides for more efficiency for the farmer and water savings by the Irrigation district.

Water Purchase Program

A water purchase program is another possible option but is more problematic. An example is between a city and Irrigation district. The irrigation district received a payment to cover the cost of improving a canal and reducing water losses. The reduction in water losses (amount of conservation) was estimated on an annual basis, and the water right for that amount of water was transferred to the city. The analogy for on-farm water conservation involves establishing the water saved by strategy and providing a financial credit from an irrigation district or agreement with the city to the famer. A major issue relates to the actual water saved/conserved by implementing a water purchase program since the farmer may decide to produce crops demanding more water or extend irrigated acreage in cases where there is land available.

State/Federal Loans

The Texas Water Development Board has an agricultural water conservation program, which lists available resources for state and federal loans. One notable program, the State Water Implementation Fund for Texas (SWIFT), requires that at least 10% of the total funding be designated for rural communities and agricultural water conservation. However, only a political subdivision of the state can apply. Although an individual farmer is not eligible, an irrigation district, city, or perhaps the Rio Grande Reginal Water Authority can apply for a loan and in turn provide resources to the farmer on a loan payback basis. This practice was perfected by the High Plains underground water districts. For SWIFT funds to be provided for a water conservation practice, the practice must be included in the Texas state water plan for a region, in this case Region M.

Issue stocks and bonds

This opportunity resembles the loan discussion above. The difference is that rather than a loan from the board, an irrigation district would use its bonding authority to obtain funds and then it could loan to a farmer at a relatively low interest rate to install water-conserving technologies on-farm. For most of the irrigation districts in South Texas, this option is not viewed as favorable since it involves debt by the irrigation district.

Water Charge based on Irrigation Technology

There are options that are most effective but politically unacceptable. Water charge based on irrigation technology is one where the incentive to adopt water-conserving technologies is driven by the cost of water to the farmer. There is a relationship between cost and amount of water used. This suggests with a higher cost on a per unit basis the farmer (or household, etc.) would begin considering alternatives in order to conserve. This could include many of the options listed above. For agriculture, the relationship of price to use is sensitive since the bottom line is profit. A second method where this concept could be applied is for the price per unit of water to be set based on water-conserving technologies on the farmer's land. The greater the expected efficiency the lower the water charge. Again, although not politically acceptable, this is an example of how economics could be used to encourage water conservation.

Meters and Per Unit of Water Rate Structure

Using meters and a per unit of water rate structure is an alternative that is used somewhat in the LRGV. Compared to the traditional method of charging on a per acre irrigated basis for irrigation regardless of amount of water applied, use of a meter system and charge per unit of water applied has been demonstrated to result in conservation. There is a trend across the irrigation districts toward use of meters and a per unit of water charge. Linking this with a SCADA system for improved district efficiency doubles the effectiveness.

Conclusions

Much of the attention for water conservation in the LRGV has targeted the irrigation districts. This is justified because the greatest potential for efficiency exits in the distribution system of districts. Furthermore, for any improvements on-farm to occur, the Irrigation district must be effective and efficient. With many of the districts adopting conservation practices and installing systems to reduce losses, it is timely to turn more attention to the on-farm irrigation efficiency and opportunity to reduce losses. The water rights system is undermining on-farm investments in water-conserving technology. This system, for the most part, means the farmer does not reap the benefits of conservation. This paper attempted to address the issue and focus on some alternatives to encourage famers to adopt conservation technologies and management strategies.

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APPENDIX

Selected illustrations of South Texas

The Rio Grande in South Texas

The Rio Grande in near Laredo

Pumping station on the Rio Grande

Cotton ready for harvest

Center Pivot Modified

Melons

Polypipe Irrigation

Arundo

Onions

Grapefruit

Gated Pipe Irrigation

Pump Intake on Rio Grande