Opportunities for Improving Agricultural Irrigation Efficiency

The agricultural sector responds to changes in water, crop, and policy through adoption and innovation. Projections in the 1970s suggested that the Ogallala Aquifer supplies would be exhausted by the early 2000s, but producers responded by using newly developed efficient technologies, and the projections did not come true. Opportunities remain for continued improvements in water use efficiency, including the following:

- Using interception (ET) networks and other tools for irrigation scheduling can significantly reduce irrigation water ET networks and thus crop irrigation water use. In one study, reduced ET was achieved using on-farm conservation practices, and the reduction in water use was significant.

Adapting Through Crop Variety Change

Science from both the public and private sector are developing genotypes in crops that improve heat and drought tolerance. Some need more efficient low-pressure systems that apply water at a lower flow rate. These systems allow farmers to grow more efficient crops with lower water use. Adoption of these technologies can significantly move productivity under hot and dry conditions.

Adapting Through Water Management

Continued development and integration of technologies focusing on maximizing rain and plant and storing with precision application systems are critical to improving water use efficiency. To provide irrigators the needed tools to help apply water only when it is needed, the network continues to evaluate and test various irrigation networks, including low flow pressure systems. With continued advancement in technology, improved irrigation networks are critical to improving water use efficiency.

Improving Irrigation Conveyance Systems

Improvement in irrigated water conveyance systems (e.g., canal lining, etc.) increase their efficiency and reduce water loss.

Agricultural Irrigation in Texas: Making Every Drop Count

Agricultural irrigation is important to Texas. Shading our soils, improving economic stability and sustainability, conserving water. Not only is irrigation an important part of the land’s water use, but it also provides food security for our citizens and our nation. Intercropping and water management is projected to save over 1 million acre-feet cumulatively in the region over the next 10 years.

The statewide economic value directly derived from irrigated agriculture was $4.7 billion in 2007 (TWDB and TSSWCB 2012). Irrigation is critical to our food production and food security and is a vital component of Texas’ productive capacity. Other studies ranked Texas first in both agricultural output and irrigated acreage.

The economic costs of lost irrigation are due to not only reduced production and associated processing but also to reduced demand for inputs such as fertilizers, chemicals, energy, and machinery. All these factors are linked throughout the state’s economy (Yates et al. 2010).
Agricultural Irrigation Concentrated in Areas Far from Urban Growth

The state’s original irrigated acres are concentrated in areas having both productive soils and available water, as shown in Figure 1. Most agricultural irrigators in the West and South Texas, far from the state’s major urban centers in Central, North, and Northeast Texas, have made significant investments to develop and implement irrigation systems (TWDB 2011). Although these costs vary by region and crop, on a statewide basis agricultural irrigation rates are comparable to or less than the rates of application by homeowner. On an annual basis, water resources used to irrigate Texas total 16.2 million acre-feet, with about 17% used for agricultural irrigation (TWDB 2012). Total annual irrigation water use remained steady, averaging approximately 9.5 million acre-feet, since the late 1970s (Figure 1). On a per acre basis, the costs of irrigation application in Texas averaged less than 18 inches annually since the 1950s (TWDB 2001). Although these costs vary by region and crop, on a statewide basis agricultural irrigation rates are comparable to or less than the rates of application by homeowner. On an annual basis, water resources used to irrigate Texas total 16.2 million acre-feet, with about 17% used for agricultural irrigation (TWDB 2012). Total annual irrigation water use remained steady, averaging approximately 9.5 million acre-feet, since the late 1970s (Figure 1).

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Over 6 Million Acres Irrigated for Agricultural Production
• One out of four harvested cropland acres in Texas is irrigated (USDA-NASS 2008).
• Irrigated acres in the state have remained relatively steady (Figure 1) for a quarter century (TWDB 2001, 2011).
• As of 2006, Texas had 6.7 million irrigated acres, making up more than 10% of the irrigated acres in the United States (TWDB 2001, 2011).

Agricultural Irrigation Concentrated in Areas Far from Urban Growth
The state’s irrigated acres are concentrated in those areas having both productive and available water supplies, such as in West and South Texas, far from the three major urban centers in Central, North, and Southeast Texas.

Annual cored water use in Texas totaled 46.2 million acre-feet in 2009, with about 17% used for agricultural irrigation (TWDB 2010). Total annual irrigation water use remained steady, averaging approximately 9.5 million acre-feet, since the late 1970s (Figure 1).

On a per acre basis, the rate of irrigation application in Texas has averaged less than 18 inches annually since the 1950s (TWDB 2001). Although these rates vary by region and crop, on a statewide basis agricultural irrigation rates are comparable to or less than the rates of application by homeowners. On an annual basis, many Texas residents use 40 to 60 inches of water per year (Duble). A 3-year study in College Station found average households supplemented rainfall by applying 22 inches annually to lawns (TWRI 2004).

Importance of Groundwater to Agricultural Irrigation
Although both surface water and groundwater are used for agricultural irrigation, the source of most agricultural water is groundwater. In 2000, 98% of the irrigated acres in the state used groundwater, 1.6% used surface water, and the remaining 0.4% used a mix of groundwater and surface water (TWDB 2001).

Groundwater is the sole source of irrigation water in the Texas High Plains, while the Rio Grande Basin and upper portions of the Gulf Coast rely heavily on surface water. Combinations of sources provide irrigation water for the White Sands (predominantly groundwater) and middle Gulf Coast (predominantly surface water) regions.

Aside from West and South Texas, far from the state’s major urban centers, the highest West and South Texas groundwater use occurs in those areas having both productive soil and irrigation demand. The state’s irrigated acres are concentrated in those areas having both productive soil and irrigation demand.
Agricultural Irrigation Concentrated in Areas Far from Urban Growth

The state’s irrigated acres are concentrated in areas having both productive soils and available water. As shown in Figure 1, most agricultural irrigation in the West and South Texas form the three most urban areas in Central, North, and Southeast Texas.

Annually corded water use in Texas totaled 32.2 million acre-feet in 2009, with about 17% used for agricultural irrigation (TWDB 2010). Total annual irrigation water use remained steady, averaging approximately 9.3 million acre-feet, since the late 1970s (Figure 1).

On a per-acre basis, the cost of irrigation application in Texas has changed less than 15% annually since the 1970s (TWDB 2001). Although these costs vary by region and crop, on a statewide basis agricultural irrigation costs are comparable to or less than the costs of application by homeowners. On an annual basis, water source itself will provide use of up to 60 inches of water per year (Duble). A 3-year study in College Station found average annual supplemental cost of by applying 22 inches of water annually to their lawn and landscape (TWDB 2004).

Increasing Yields without Increasing Water Use

While statewide agricultural irrigation rates have increased significantly, on average, a College Station study found that supplemental irrigation increased yields by 12% annually, as much as doubling crop production (Duble). Although crop genetics have helped increase productivity, improved genetics do little without water. In competition with non-agricultural uses (recreation, production, irrigation, power) and water availability, increasing yields without increasing water use makes little sense without water.

Water Supply and Demand Challenges

Water demands challenge the state more than any other natural resource issue. Demand already exceeds supplies in six of the 16 water planning regions (Figure 4). By 2060, demand will exceed supplies in all regions except two.

Increasing Urbanization

Rapid development and expansion of urban areas are decreasing the amount of land available for irrigated agriculture and that is increasingly concentrated in Regions 5 and 6. Many of these acres are being converted to residential areas with significant quantities of original agricultural land bases. Further, surface water supplies available for agricultural irrigation are decreasing in water demands for municipal and irrigation needs (Figure 4). In Region C, 5%, and 6, municipal demand increases because of more than 10% are expected by 2060 (Table 1). The number of people moving from urban growth is facing many acres to risk obtaining water from other regions. With the projected doubling of the population of Texas over the next 50 years, sustaining irrigated agriculture will become even more challenging because of the competing demands generated by this growth. It will also become more important with the increasing food demands of this population and need for a secure food supply.

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<th>Region</th>
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Table 1: Changes in existing (as of 2010) and future (2060) water demands for municipal and irrigation needs in each water planning region (TWDB 2012).
Mass Conversion to Efficient Irrigation Systems

Historically, most agricultural irrigation was applied using flood and furrow irrigation, however, most of these irrigation systems are now being converted to more efficient systems to reduce water losses (Figure 6). Beginning in the late 1970s, center pivot irrigation systems became commercially available, and by 1994 they had been adopted on nearly half of Texas’s irrigated acres. During that time, center pivot systems evolved from high-pressure machines that sprayed water over the crop canopy to eminently effective low-pressure machines that can be automated (Figure 5). Beginning in the late 1970s, center pivot irrigation systems became commercially available, and by 1994 they had been adopted on nearly half of Texas’s irrigated acres. During that time, center pivot systems evolved from high-pressure machines that sprayed water over the crop canopy to eminently effective low-pressure machines that can be automated (Figure 5). Beginning in the late 1970s, center pivot irrigation systems became commercially available, and by 1994 they had been adopted on nearly half of Texas’s irrigated acres. During that time, center pivot systems evolved from high-pressure machines that sprayed water over the crop canopy to eminently effective low-pressure machines that can be automated (Figure 5).

As of 2008, center pivot irrigation systems were used on nearly 80% of Texas’s irrigated acres, and 87% of those acres are using low-pressure center pivot systems. Flood and furrow irrigation accounts for less than 4% of irrigated acres today. The highly efficient center pivot irrigation systems, in which there is minimal evaporative loss, is increasingly being adopted and now comprises almost 3% of irrigated acres (Figure 6).

Because of the adaptive ability of farmers, irrigation efficiency has increased from 60% to 88–95% in much of the state today, allowing Texas to get much more value and agricultural production from its water.

Irrigation growth: mass conversion to efficient systems

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The economics of center pivot irrigation systems are based on large increases in yield and labor productivity. As of 2008, center pivot irrigation systems were used on nearly 80% of Texas’s irrigated acres, and 87% of those acres are using low-pressure center pivot systems. Flood and furrow irrigation accounts for less than 4% of irrigated acres today. The highly efficient center pivot irrigation systems, in which there is minimal evaporative loss, is increasingly being adopted and now comprises almost 3% of irrigated acres (Figure 6).

Economic Impact of Irrigated Agriculture

Many communities depend on irrigated agriculture for continued viability. The statewide economic value directly derived from irrigated agriculture was $4.7 billion in 2007 (TWDB 2001, 2011; USDA-NASS 2008). Texas is at the forefront of efficient water resource management, and irrigation conservation is an important component of the state’s water policy (TWDB and TSSWCB 2012). Opportunities for improving agricultural irrigation efficiency continue to grow.

Opportunities for Improving Agricultural Irrigation Efficiency

The agricultural sector responds to changes, and farmers and ranchers have demonstrated their ability to adapt to changes in water supplies and regulations. Projections in the 1970s suggested that the Ogallala Aquifer recharge reduced by the early 2000s, but producers responded by using newly developed efficient technologies, and the practice continues to grow. Opportunities for continued improvements in water use efficiency, therefore, are significant.

Using remote sensing (ET) networks and other tools for irrigation scheduling can significantly reduce irrigation water ET requirements while maintaining crop yield and quality. Significant advances have been made in irrigation efficiency; however, challenges remain. The economic costs of lost irrigation are due not only to reduced production and associated processing, but also to reduced demand for inputs such as fertilizers, chemicals, energy, and labor. All these factors are linked through the entire economy (Yates et al. 2010).

Irrigation efficiency has grown from 60% to 88%–95% in much of the state today, allowing Texas to get much more value and agricultural production from its water.

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Irrigation is critical to our food production and food security and is a vital component of Texas’s productive agricultural economy. As noted in the 2012 Status and Trends of Irrigated Agriculture in Texas report, the economic value directly derived from irrigated agriculture is an important part of the state’s economic output. The Texas Water Development Board (TWDB) and the Texas A&M University also support this report through their financial contributions. This report has been developed to provide a valuable perspective on the status and trends of irrigated agriculture in Texas.
Irrigation efficiency has grown from 60% to 88% over the past 50 years to nearly 90% of the state today, allowing Texas to get much more water value and agricultural output from its water. Significant advances have been made in irrigation efficiency; however, challenges remain. The agricultural sector contributes to more than one-third of the state’s economy, and irrigation conservation is an important component of the state’s water resource management strategy. The Texas Water Development Board, the U.S. Department of Agriculture National Agricultural Statistics Service, Texas State Soil and Water Conservation Board, and Texas A&M AgriLife Research and Extension Service.

Kevin Wagner, Ph.D.

Opportunities for Improving Agricultural Irrigation Efficiency

The agricultural sector responds to changes, and farmers and ranchers have demonstrated that by adapting to changes in water supplies, costs, and regulations. Projections in the 1980s suggested that the Ogallala Aquifer supplies would be used beyond the early 2000s, but producers responded by using newly developed efficient technologies, and the practice continues today. Opportunities remain for continued improvements in water use efficiency, including the following:

- **Scheduling with Drip Irrigation**: Using microirrigation (ET) networks and other tools for irrigation scheduling can significantly reduce irrigation water ET networks, resulting in a substantial reduction in water use. In Texas, for example, irrigating turfgrass at the right time can reduce water use by over 30% compared to conventional irrigation. Irrigation systems can then be designed to determine the optimal irrigation schedule.

- **Smaller Irrigation Systems for Smaller Fields**: In the 1970s, center pivot irrigation systems became commercially available, and by 1990 they were adopted on nearly half of Texas’ irrigated acres. During this time, center pivot systems evolved from high-pressure machines that sprayed water over the crop canopy to eminently controllable low-pressure center pivot systems. Today, center pivot systems are used on nearly 80% of Texas’ irrigated acres, and 87% of those acres are using low-pressure center pivots.

- **Improved Irrigation Management Systems**: Improved irrigation management systems can be used to optimize irrigation schedules, thereby reducing water use and improving crop yields. These systems can then use this information to determine optimum irrigation management on a daily basis. In the 2011 Region A water plan, irrigation districts are encouraged to adopt advanced technologies for real-time weather station monitoring and irrigation management. ET sensors are being developed to improve irrigation efficiency. These advances may provide significantly more productivity under hot and dry conditions.

- **Irrigation Efficiency and Water Management**: Continued development and integration of technologies focusing on monitoring soil and plant stress and precise ET sensors allow for improving water use efficiency. To provide the irrigation industry the tools to achieve these goals, the USDA-Natural Resources Conservation Service and Texas State Soil and Water Conservation Board report that through their programs alone, farm- ers in Texas have improved irrigation water management on over one million acres since 2000. This reflects only a portion of the improvements adopted.

Irrigation is important in Texas, doubling many fields, improving economic stability and sustaining agriculture. Not only is irrigation an important part of the broader food and fiber sector—which accounts for 9% of the state’s economy—it also provides food and fiber to millions of people around the world. Improved irrigation efficiency and water use efficiency not only remove waste but also improve water use efficiency.

**Improve Agricultural Irrigation Efficiency in Texas: Making Every Drop Count**

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**Economic Impacts of Irrigated Agriculture**

Many economists depend on irrigated agriculture for continued viability. The statewide economic value added from irrigated crops was $4.7 billion in 2017 (TWDB and TSSWCB 2012).

**Economists Impacts of Irrigated Agriculture**

Historically, impacts of irrigation vary by region. In the Texas High Plains, the total regional economic impact of converting all irrigated acres from flood and furrow irrigation to center pivot systems is estimated to be over $1.5 billion per year, over $350 million of which is added, and nearly 7,398 jobs (Yates 2010). Loss of irrigation in the Winter Garden (Fresno, Tulare, and Madera counties) could result in the loss of 13% of their farm base; and a 30% loss in the Salinas Valley (Monterey County) could result in the loss of 30% of their farm base (AgriLife Extension 2009). In Dade City, however, total economic impact of irrigation is estimated at $478 million and support over 10,000 jobs (Yates 2010). However, due to a more productive and efficient method of agriculture with less labor, less water, and less land needed, this estimate is probably on the low end (Whitney and Whitaker 2004).

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