Agricultural Water Conservation

Irrigation Water Use Management

BEST MANAGEMENT PRACTICES

Texas Water Development Board
Conservation Division

No one knows better than Texas farmers and ranchers that agriculture depends on water. Because our state is prone to drought, the lack of water often limits the production of food and fiber crops. As a result, producers often rely on irrigation to provide sufficient water for agricultural needs. In arid areas, crop production is not possible without irrigation water. In semiarid areas, irrigation water increases crop yields and quality. In humid areas, supplemental irrigation increases yields for certain specialty crops. For many Texas producers, irrigation water is essential and will continue to be so, especially during periods of erratic rainfall and drought. However, with declining water supplies in many areas of the state and the escalating need to conserve water, producers must address the challenge of managing their irrigation water use as efficiently as possible.

The primary objective of this booklet is to inform agricultural irrigators, irrigation water districts, and groundwater conservation districts about irrigation water use management practices. The practices are explained, and guidelines on how to adopt these practices are suggested. The best management practices (BMP) that together form the core of irrigation water use management are:

BMP 01 Irrigation scheduling

BMP 02 Measurement of irrigation water use

BMP 03 Crop residue management and conservation tillage

BMP 04 Irrigation audit

Irrigation systems

To irrigate effectively, the right amount of water has to reach the right place at the right time. Generally, greater amounts are applied with gravity systems than with sprinkler and micro-irrigation systems. The common types of irrigation methods in Texas are given in Table 1.

Table 1. Irrigation systems and methods used in Texas

System	Method	Description
Surface (Gravity)	Flood	Water is diverted from ditches to fields or pastures
	Furrow	Water is channeled down furrows for row crops or fruit trees
	Border	Water is applied to sloping strips of fields bordered by ridges
	Surge	Valves control delivery of water to fields in intermittent surges
Sprinkler (Pressurized)	Pivot & linear systems	High pressure
		Medium pressure
		Low pressure
	Side rolls	Mobile pipelines deliver water across fields using sprinklers
	Solid set	Pipes placed on fields deliver water from raised sprinkler heads
Micro-irrigation (Pressurized)	Surface	Emitters along pipes or hoses deliver water directly to the soil surface
	Sub-surface	Emitters along pipes or hoses deliver water below the soil surface
	Micro-sprinklers	Emitters on short risers or suspended by drop tubes sprinkle or spray water above the soil surface

BMP 01: IRRIGATION SCHEDULING

Irrigation scheduling is a practical tool for preventing the over-application of water while optimizing crop growth. Most producers know how long it takes to irrigate fields and avoid crop stress during average conditions. With erratic rainfall, however, it becomes difficult to apply enough water to fill the effective root zone without unnecessary deep percolation or runoff.

Why schedule irrigation?

Efficient irrigation scheduling can significantly reduce the amount of irrigation water pumped and avoid excessive energy use. By managing irrigation systems to use as much rainfall as possible, producers do not have to pump water from aquifers or use water released from reservoirs. Two of the most important decisions an irrigator has to make are when to start and stop irrigating each season. To help make those decisions, the producer should monitor the moisture content of the soil and assess the actual irrigation system capacity. This information is critical for keeping tabs on the ability of the individual irrigation system to keep up or catch up with crop water demand. Despite lower water use rates in the early growing season, the soil may dry quickly without the producer realizing it. As a result, the irrigation system may not be able to catch up with the crop water demand, and the crop yield may suffer. Delaying irrigation for as long as possible is desirable, provided that it does not cause yield reduction.

How do I schedule irrigation?

At the start of the season, producers should plan a strategy that encompasses decisions about when and where to irrigate and how much water to apply. The strategy should be based on a good understanding of crop water use. The advantages and limitations of the three popular methods of measuring crop water use are presented in Table 2.

Table 2. Three methods of measuring crop water use

Soil moisture measurements	Throughout the growing season, producers need to know the current moisture status of the soil. There are several soil moisture tools and devices available on the market. Each of these devices has distinct advantages and limitations. Discuss your options with an irrigation expert before using one.
Plant water measurements	The plant is the link between the soil and the atmosphere. Its water status provides an indication of when to irrigate. Because individual plants are measured, this method is more commonly used for orchards and tree crops.
Evapotranspiration measurements	Water use data from an automated evapotranspiration network is generally processed at central locations and broadcasted in near-real time. The evapotranspiration network information can be used to improve your decision making for irrigation scheduling. Discuss training sessions with an irrigation expert.

Where can I find more information?

Using soil moisture measurements combined with water requirement predictions from the evapotranspiration network is the most effective method for making decisions on scheduling irrigation. However, adopting both methods in tandem is a formidable task. The practical option for producers is to engage in experiential learning. Observe keenly the practicality of adopting each of the methods in your production system. Participating in irrigation training workshops or peer training can help producers determine which methods are most appropriate for them. The U.S. Department of Agriculture's Agricultural Research Service, Texas AgriLife Research and AgriLife Extension, and Texas Tech University conduct formal training sessions and workshops. These usually include tours to fields equipped with soil moisture probes and evapotranspiration network stations. The Texas Water Development Board (TWDB) has worked closely with all three institutions on training. For additional technical information and for opportunities on possible training and tours, please visit these Web sites:

http://www.ars.usda.gov/main/site_main.htm?modecode=62-09-05-05
http://txhighplainset.tamu.edu/
http://texaset.tamu.edu/

BMP 02: MEASUREMENT OF IRRIGATION WATER USE

Measuring water use is a key step in managing irrigation water use. Producers may choose from several technologies, methods, and calculations to assist them with this practice. In Texas, some producers use meters to measure their water use, and others rely on automated water canal delivery information systems. The automated system allows irrigation district personnel to open or close gates at pumping stations and monitor flow rates from a remote location.

Why measure irrigation water use?

Measuring irrigation water use provides critical information to the State of Texas, producers, local groundwater conservation districts, irrigation districts, and regional water planning groups. Because agricultural irrigation currently accounts for about 60 percent of all water demand in Texas, state planners need accurate information on irrigation water use to estimate future needs. Groundwater conservation districts and irrigation districts rely on irrigation water use information to quantify the effects of water withdrawals on aquifers and surface water sources, which assists these groups in responsible resource management. Some groundwater conservation districts require producers to report irrigation amounts for every growing season, using the data to estimate the volume of water pumped within their territorial jurisdiction. The water use information also assists regional water planning groups in projecting future water supplies in their areas.

How do I measure irrigation water use?

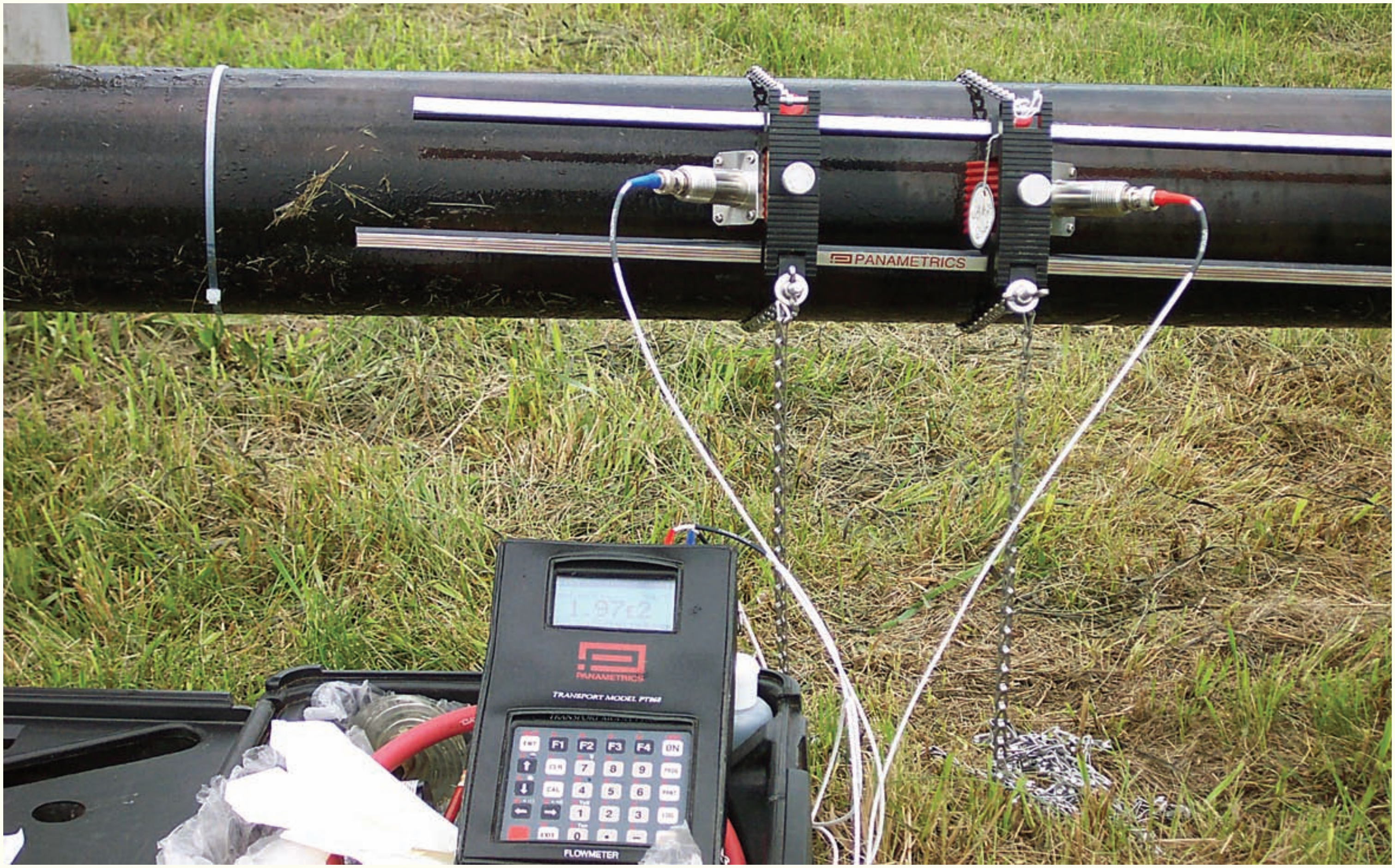
There are numerous methods for measuring water use, and some are listed in Table 3.

TWDB manages a voluntary irrigation metering program to monitor irrigation water use at producers' sites. Through this program, financial assistance is provided to local districts to install meters in producers' fields. Currently, four groundwater conservation districts are participating in the program, and together they report data from over 430 irrigation meters. TWDB has also funded the construction of a few facilities in the Lower Rio Grande Valley and in the Texas High Plains to provide

meter calibration services to producers. More recently, TWDB awarded contracts to some irrigation districts to develop and test low-cost canal gates for surface water delivery systems.

Table 3. Flow measurement methods commonly used in Texas

Direct measurements for closed channels and pipelines	Propeller or impeller meters
	Orifice, venturi, or differential pressure meters
	Magnetic flux meters (both insertion and flange mount)
	Ultrasonic meters (travel-time method)
Direct measurements for open channels	Weirs and flumes
	Stage discharge rating tables
	Area/point velocity measurements
	Ultrasonic (doppler and travel time methods)
Indirect measurements	Energy used by a pumping plant
	Elevation change of water level in a storage reservoir
	Timing and estimated flow rate



Where can I find more information?

To see if you qualify for federal funding assistance to defray the costs of flow meters, visit your local Natural Resources Conservation Service office. Some groundwater conservation districts and irrigation water districts may also share some of the capital costs by using TWDB grants.

References

Enciso, J., Santistevan, D., and Hla, A., 2007, Propeller flow meter: Texas AgriLife Extension publication number L-5492, 4 p.

Martin, E., 2009, Measuring water flow and rate on the farm: Arizona Cooperative Extension publication number AZ 1130, 4 p.

BMP 03: CROP RESIDUE MANAGEMENT AND CONSERVATION TILLAGE

Crop residue management and conservation tillage are two separate practices but are considered one best management practice because they are closely related. Crop residue management conserves some of the remains of a previous crop on a field. Generally, crop residue can be left in situ during harvest with a combine or spreader. Conservation tillage reduces the intensity of soil-disturbing operations, often limiting tillage passes. Different tillage systems include no till, mulch till, strip till, and ridge till. Producers should consider integrating these practices and implementing them in tandem to maximize conservation benefits.

Why adopt residue management and conservation tillage?

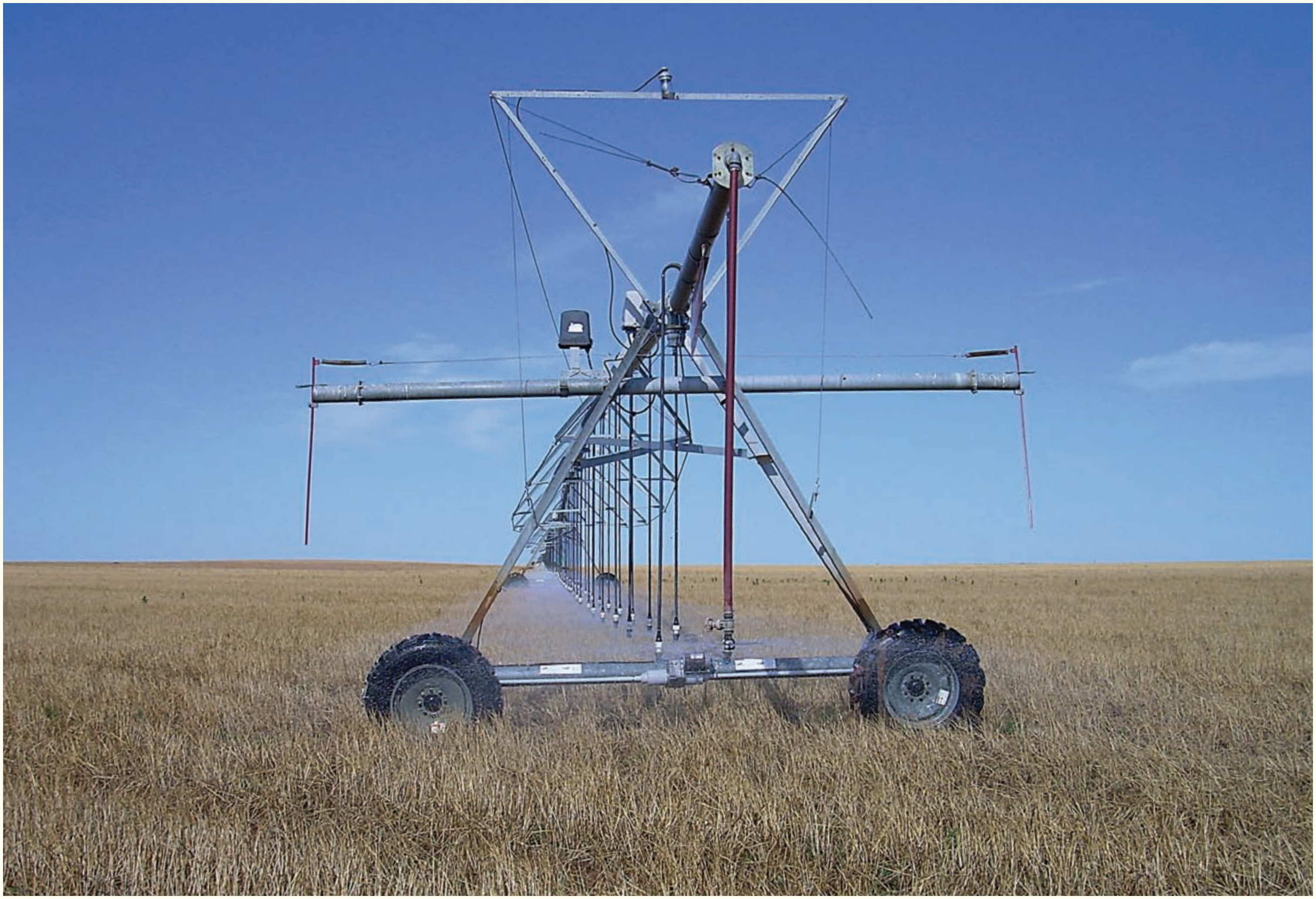
Crop residue management helps reduce soil erosion, captures precipitation (snow and rain), and reduces runoff. In the long term, the practice may improve soil physical properties by adding organic matter to the soil and enhancing soil health. Keeping the crop residue even across the field is essential for spreading nutrients uniformly and shielding new plants from adverse weather conditions. Residue covering 30 percent of a field is considered adequate.

Conservation tillage minimizes soil disturbance and increases oxygen levels within the soil. It also reduces air pollution, limits soil compaction, and helps maintain a habitat for beneficial bugs and nutrients within the soil. By adopting conservation tillage, producers can lower fuel consumption and labor costs by decreasing material inputs and spending less on maintenance. Other benefits include improved weed suppression, increased percolation and infiltration, and decreased amount of evaporation of water from the soil surface.

How do I adopt crop residue management and conservation tillage? Irrigation producers may find it hard to adopt crop residue management and conservation tillage because to do so requires dedicated cultural changes. Producers with pressurized sprinkler irrigation systems may find the adoption less of a cultural shift than those who depend on gravity water delivery systems. With gravity irrigation systems, traditional tillage prepares the field for both planting crops and supplying irrigation water.

Adopting this practice is a learning process and may take several years to fully master. This best management practice will work best if crop residue management and conservation tillage are implemented in tandem. There are several factors that will affect this practice. For example, the equipment used, the tillage operation speed, and the crop type will determine how much residue may be left. Crop hybrid selection and variety traits are elements to consider because good germination potential under cooler conditions, early growth, vigorous root system, good stand under high populations, and high yields are better suited to this practice.

Farming with conservation tillage may require initial investments for new and specialized tilling accessories for field preparation. Producers should discuss options with peers who have successfully implemented this practice and who may be willing and able to lease their equipment or perform custom operations. The key to adopting the practice is to plan meticulously, start small, and experiment with trial runs before implementing it on a large scale.



Where can I find more information?

The best option for acquiring additional information on crop residue management and conservation tillage is your local office of the Natural Resources Conservation Service. Through its Environmental Quality Incentive Program, the Natural Resources Conservation Service offers a wide range of cost-share options. Texas AgriLife Extension and Texas AgriLife Research also provide ample opportunities for field tours of crop residue management and conservation tillage demonstrations around the state. Contact your local county agent or soil conservation specialist for information about training events in your area.

References

Lemunyon, J., and Gross, C., 2002, Conservation tillage and crop residue management: Natural Resources Conservation Service, 2 p. Available online at http://www.sera17.ext.vt.edu/Documents/BMP_tillage.pdf.

BMP 04: IRRIGATION AUDIT

An irrigation audit is the testing process to assess an irrigation system's performance. The Texas Water Conservation Implementation Task Force pointed out that this is the initial conservation practice producers should use to increase irrigation water efficiency. For gravity irrigation systems, the audit can assess on-farm water use, identify problems, and find ways to solve them. For pressurized sprinkler irrigation and micro-irrigation systems, the irrigation audit can provide more in-depth assessments. A complete analysis of the pressurized irrigation system is possible because all components of the irrigation system are generally located at one site. For example, an irrigation audit for a sprinkler irrigation system that has a pumping plant, well, and center pivot can assess the effectiveness of all component parts to determine the efficiency of the whole system. Generally, this practice is performed by experienced service providers, but it can also be conducted by the producers.

Why should I have an irrigation audit performed?

By auditing any irrigation system on a regular basis, producers can monitor the water use trend over a period of time. Because an irrigation audit provides critical information about an irrigation system's efficiency, it can be used to detect problem areas before they become endemic to the whole system.

An audit conducted for gravity irrigation systems can determine the time needed to distribute water adequately throughout the irrigated fields. Producers can also use the audit information to resize, reshape, and level the fields so that water can be delivered more rapidly and effectively.

An irrigation audit on pressurized systems can inform the producer how evenly irrigation water is being applied. This information is essential for producers to know when to replace key components such as sprinkler heads or emitters. The audit report will allow the producer to compare the original and current flow characteristics of the pumping plant and gauge the pumping plant's working condition. Information in the report may also be used to determine the mismatch of the system capacity with the flow characteristics of the pumping plant. Conducting irrigation audits on a regular basis helps the farmer schedule maintenance work for the well, pumping plant, and sprinkler heads or micro-irrigation emitters.

How do I conduct an irrigation audit?

A typical irrigation audit generally has three distinctive phases:

Phase 1 — Data collection: The cooperation of the producer is paramount for meticulously collecting key information, which can include sketches or maps of fields, the locations of water supply networks, meters or measuring points, and inventories of pumping plants. Field information about crop types, field slope, soil types and textures, and infiltration rates is also important. The irrigation scheduling method, water use data from previous years, and copies of prior irrigation audits can also be important, in addition to well construction information and well testing records.

Phase 2 — On-site audit: The on-site physical irrigation audit should verify water use in the fields by assessing the performance of the irrigation pumping plant while it is being used. For the gravity irrigation system audit, an orifice plate, flume, weir, propeller meter, soil moisture

probe, level instrument, chain, or measuring tape may be needed. The tools of the trade for conducting an audit on pressurized irrigation systems may include a portable flow meter, stopwatch, pressure gauge, graduated measuring cylinder, soil sampling probe, and catch can.

Phase 3—Audit report: The data gathering and on-site audit phases should provide enough information to generate the audit report. This report may contain information on current equipment, recent irrigation schedules, and identified water uses throughout the operation. The irrigation audit report generally provides practical options for scheduling maintenance work to improve irrigation systems. More importantly, it also serves as a guidance tool for making innovative management changes.

Where can I find more information?

Some groundwater conservation districts provide the irrigation audit as a service. The local offices of the Natural Resources Conservation Service may cost share this practice as part of the irrigation system improvement programs under the Environmental Quality Incentive Program.

References

Natural Resources Conservation Service, 1997, National engineering handbook Part 652—Irrigation guide, 754 p. Available online at http://www.wsi.nrcs.usda.gov/products/w2q/downloads/Irrigation/National%20Irrigation%20Guide.pdf.

LOANS AND GRANTS

These irrigation water use management practices are eligible for funding under the Natural Resources Conservation Service incentive programs. TWDB-administered loan and grant programs may also support the adoption of these practices. Since the inception of the TWDB agricultural conservation program in 1985, over $50 million in loans has been provided to local institutions for improvements in irrigation systems. TWDB has also provided about $15 million in 313 grants to local districts and universities for promoting the adoption of agricultural irrigation water use practices. In addition, local districts implement water conservation best management practices by leveraging federal and state incentives and disseminating education to producers.

For further information on loan and grant opportunities, contact the TWDB Agricultural Conservation Team Lead at 512-463-7940, or visit the TWDB Web site: http://www.twdb.state.tx.us/assistance/conservation/agricons.asp

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