WATER USE EFFICIENCY MEASURES & PROGRAMS
FOR
AGRICULTURAL WATER USERS

INTRODUCTION

The following list of agricultural and nursery water use efficiency measures was prepared as part of the Central Florida Water Initiative during its Solutions Planning Phase. However, agricultural and nursery water users throughout Florida may be able to improve their water use efficiency through implementing any of these measures as applicable to their specific operation(s). Other measures not included in this list may also be applicable.

Electronics

AMR/AMI Technology –
This practice entails the remote monitoring of meter readings using an irrigation system controller or computer system. This technology allows leaks or problems in the irrigation system to be detected immediately and the pump shut down to prevent excess water loss. Some growers apply water based on the number of gallons per plant and the automatic meter readings are used to shut the pump off when the desired volume per plant is reached.

Automated Valves –
This involves the utilization of irrigation system valves which can be operated remotely or automatically shut off when a sensor indicates a certain water level, soil moisture level, irrigation volume or time interval is reached. Water savings are realized over manually operated valves primarily due to operator inconsistencies (e.g. letting water flow too long) as logistics often prevent growers from ending irrigation at the ideal time.

Auto Pump Start / Stop –
Use of these devices automates the starting and stopping of the engine driving the irrigation pump. Pump/engine starting and stopping can be controlled by the grower remotely or based on other sensor data such as rain or soil moisture sensors. Water is conserved by allowing growers or farm managers who are responsible for multiple pumps (often greater than 10) to start and stop pumps based on crop needs instead of when time allows them to visit each pump station.

Multi-stage Greenhouse Control Systems –
In Florida, greenhouse cooling using fog or fan and pad evaporative systems is common. As temperatures rise multi-stage controllers can separately open greenhouse vents, then run cooling fans and then delay turning on the fog system or wetting system for the evaporative cooling pads until needed. These controllers operate in the reverse direction as temperatures cool down. These adjustments as to when water is used can reduce the amount of water lost to evaporation.

Smart Irrigation Controllers –
Use of these devices allow the grower to schedule irrigation using the inputs from many sensors or sources based on the crop water needs. Inputs can include soil moisture, rainfall, wind, and forecasted rainfall. These controllers can be configured to automatically start or stop irrigation based on the input or will alert the grower of action needing to be taken. In some cases no real time data is input to the controller, but the controller is used to schedule irrigation to supply only the crop water needs. Water is conserved by providing the grower with the information to irrigate to the water needs of the crop or automatically controlling the system based on crop water needs.

Soil Moisture Sensor(s) –
These devices are used to interrupt the operation of an irrigation system when the soil reaches field capacity or excess irrigation water is draining below the root zone of the crop. Water is conserved by preventing the application of water when it is not necessary. Soil moisture sensors can also indicate when the soil moisture drops too low and irrigation is required. In some cases, the use of this measure has increased water use.

Weather Station with ET Measurement –
This measure involves utilizing an irrigation controller or computerized system that incorporates real-time weather data to automatically update scheduled irrigation events. This can include a rain sensor that interrupts the operation of an automatic irrigation system during and after rainfall events. Some irrigation controllers do not automatically change scheduled irrigation events, but the data collected by the weather station can be used by the grower to limit irrigation to only the amount of water that was not supplied by rainfall.

<u>Irrigation System Retrofit</u>
Irrigation Retrofits to a More Efficient Irrigation System-
This practice involves replacing an existing irrigation system with a more efficient system. Some examples of system retrofits are listed below; however, this is not intended to be an exhaustive list of current or future retrofit options.

> *Drip / Micro-Irrigation System Conversion* –
> This practice involves the replacement of an irrigation system with a more efficient irrigation method that uses low-flow hardware (e.g. drip and/ micro-irrigation) to deliver water near the plants' root zone. The applicability of this is dependent upon crop type.
>
> *Fully Enclosed Seepage Irrigation System Conversion* –
> This involves the replacement of open or semi-closed seepage irrigation systems with a more efficient fully enclosed seepage system. Fully enclosed seepage irrigation systems increase irrigation efficiency by reducing losses due to evaporation and runoff from open or semi-closed seepage irrigation systems.
>
> *Gated and Flexible Pipe for Field Water Distribution Systems –*

This practice involves the use of gated and flexible irrigation piping in an agricultural operation. This is applicable to agricultural producers who plant row crops and is used to reduce water runoff from the furrows. This practice reduces runoff and increases infiltration of rain or applied irrigation. (Source – Best Management Practices for Agricultural Water Users, Texas Water Development Board, November 2013). Furrow dikes are typically utilized in arid and semi-arid regions, so applicability in Florida is limited.

Irrigation and Lateral Canal Replacement with Pipelines –
This practice entails the replacement of open channels (irrigation and lateral canals) with pipelines. This decreases conveyance losses from seepage. This practice is applicable to water districts that use open channels to convey water from a source to farms or irrigation turnouts, and as an alternative to lining the canals. Application is limited by canal capacity (typically limited to canals with less than 100 cfs capacity) and cost. In Florida, water district irrigation canals often also serve as drainage conveyance during the wet season, requiring even greater flow capacities – this further impacts the applicability of this practice in Florida.

Linear Move Sprinkler Irrigation System Conversion –
This practice involves increasing irrigation efficiency by installing a more efficient linear move sprinkler irrigation system in place of a lesser efficient irrigation system.

Lining of Irrigation Canals and On-Farm Irrigation Ditches –
This practice involves the lining of open conveyance canals and on-farm ditches with a lining of impervious material to decrease conveyance losses from seepage.

Low Pressure Center Pivot Sprinkler Irrigation System Conversion –
This involves the replacement of an irrigation system with more efficient low pressure center pivot sprinklers. This type of system increases the irrigation efficiency by reducing losses due to evaporation and runoff when compared to high pressure center pivot systems or seepage irrigation systems.

On-Farm Irrigation Ditch Replacement with Pipelines –
This practice entails the replacement of on-farm conveyance ditches with pipelines. This practice decreases conveyance losses from seepage by replacement of open channels with pipelines. This practice is applicable to irrigated farms that use an open ditch to convey irrigation water, and as an alternative to lining the ditch. This practice is limited by ditch capacity (typically limited to ditches with less than 5 cfs capacity) and cost. Cost effectiveness is variable based on site-specific seepage rates in open channels and required pipe size based on capacity. (Source – *Best Management Practices for Agricultural Water Users*, Texas Water Development Board, November 2013).

Overhead Irrigation of Containerized Plants Replacement with Subirrigation –

Subirrigation systems (capillary mat, ebb and flow, flood floor and trough) are very effective at reducing water use. These systems also reduce needed fertilizer inputs and may reduce foliar diseases.

Maintenance and Management

Cyclic Scheduled Irrigation; *Applying Water in Several Short Cycles Rather than One Long Cycle* –

This practice entails the application of surface irrigation over a short period of time until surface water pooling starts to occur, and then stopped to allow infiltration. This is applicable to nearly all direct application (i.e. – surface) irrigation methods, applying irrigation in short bursts rather than in longer cycles. This conserves water by reducing runoff, thereby increasing application efficiency. Cyclic irrigation can also be used to decrease water loss in container nurseries.

Irrigation Scheduling –

This practice involves the development of an irrigation schedule used to determine when and how much to irrigate crops based on the irrigation system type and efficiency, weather conditions, crop requirements, and soil characteristics. Local weather stations and soil moisture-sensing devices can help adapt the schedule to the actual real time site conditions.

Irrigation System Evaluation (or Survey) –

This involves the collection of information about and evaluation of a grower's irrigation system by a trained mobile irrigation lab technician. Recommendations for system improvements and more effective irrigation scheduling and, in some cases, the redesign of the irrigation system are then provided. Typically, if all recommendations are implemented, overall system irrigation efficiency can improve by an estimated 15-20 percent.

Net Irrigation Requirement Based Irrigation Determination –

The difference between the daily crop demand (evapotranspiration) and the daily effective rainfall (amount of natural rainfall available to the plant's root zone which excludes deep percolation, runoff, and plant interception) will closely predict the daily net irrigation requirement. This practice entails the tracking of a water balance estimate, by a trained technician (Irrigation Auditor), to give the grower a refined schedule of when to irrigate and how much water to apply.

Routine System Maintenance –

This practice involves inspecting the irrigation system components for compromised integrity and ensuring that any previously replaced emitters are compatible with the original irrigation system design. Pressure losses through leaks and inappropriately sized components can cause inefficiencies and non-uniform irrigation patterns throughout the production field.

Volumetric Measurement of Irrigation Water Use –

This practice entails maintaining an accurate assessment of the irrigation water use. Helpful direct volumetric measuring devices include properly calibrated (propeller/magnetic flux/ultrasonic) flow meters and pipe pressure meters. Indirect measuring devices include energy use of the pump and the duration of the irrigation event.

Water Budget Development –
This practice involves evaluating natural rainfall and plant evapotranspiration to determine the relationship between input and output of water to and from the site. The budget takes into account plant type, plant water needs, irrigation system design, and the water received by the crop's root zone either by rainfall or irrigation during times of water deficit. Water budgets are associated with a specific amount of time (example: weekly) to schedule irrigation events.

Water Control

Furrow Dikes –
This practice involves the addition of dikes in irrigation furrows to control distribution of surface water within the field. This reduces seepage losses associated with open channel distribution, and increases efficiency and uniformity of delivery to the furrows (for instance, by reducing deep percolation of irrigation water near the head of the field). Cost effectiveness is variable based on site-specific seepage rates in open channels, and field layout (i.e. – furrow spacing, etc.) – approximate range of savings is $20 to $25 per acre-foot. (Source – Best Management Practices for Agricultural Water Users, Texas Water Development Board, November 2013).

Water Control Structures –
This practice involves the use of a structure or series of structures in a water management system to convey water, control the direction or rate of flow, and/or maintain a desired water surface elevation. Typical water control structures may consist of one or a combination of drops, chutes, turnouts, surface water inlets, pipe drop inlets, box inlets, head gates, flashboard risers, culverts, and pipes, all in varying sizes and shapes.

Water Table Observation Well(s) –
This practice entails the use of water table monitor wells placed in agricultural fields to show the grower how high the water table is in the field. The depth to the water table indicates whether further irrigation is required and prevents irrigation when it is not needed. Depth readings can be read either manually or monitored remotely. This practice is limited to certain soils, such as those with a spodic or clay horizon.

Additional Practices

Brush Control / Management –
This practice involves the removal and/or reduction of brush to reduce evapotranspiration. It is typically applicable to non-irrigated land in areas with sufficient rainfall. Brush near the crop competes with the crop for the available water resulting in a need for irrigation.

Where brush has become established and presents a problem or in riparian areas, a feasibility study may be required to determine a water conservation program.

Crop Residue Management and Conservation Tillage –
This involves soil tillage to improve the ability of soil to hold moisture, reduce the amount of water that runs off the field, and reduces evaporation of water from the soil surface.

Group Nursery Plants According to Water Needs –
This practice involves the practice of grouping plants with similar water needs together (to be irrigated on the same irrigation zone). Water savings are realized by not overwatering plants with a lower irrigation need in order to meet the higher irrigation demands of plants in the same irrigation zone.

Laser Land Leveling –
This practice entails using a laser transmitter to produce a horizontal laser plain to grade a field to the conditions needed to conserve water use on the site. This practice increases irrigation uniformity and decreases runoff.

Other Proven Water Conservation Techniques and Ideas –
This practice allows for the introduction of new or other proven water conservation and water savings techniques, measures and ideas from being included for water conservation and/or savings. These measures must be proven to have a net water resource benefit consistent with this plan and may include practices currently being researched, unknown, or not presently recognized and proven in this list of Agricultural BMPs. These BMPs are considered on a case-by-case basis, and may or may not be considered for cost-share assistance.

Reclaimed Water –
This practice is intended to increase the efficiency and use of reclaimed water projects to reduce or conserve groundwater or other water source uses intended for agricultural irrigation purposes. These measures may include pipe connections and other water collection and delivery system items and hardware when connected into an existing waste water treatment plant's reclaimed water line running along the agricultural operations property limits.

Shade Control Structures –
This practice involves the installation of structures to provide shade and temperature control from direct sun light, reducing evapotranspiration and soil drying, which reduces irrigation needs. Shade structures provide other advantages for crops such as: bird protection, hail protection, and some wind protection. Since shade structures can reduce air mixing during cold radiation events, temperatures inside are often colder than outside so the need for supplemental heating may be increased.

Soil Amendments –
This practice involves amending the soil to provide a better environment for plants to grow. Some soil amendments improve its physical properties, such as water retention,

permeability, water infiltration, drainage, aeration and structure. Improved soil conditions can decrease the frequency of required irrigation.

Surge Flow Irrigation Use for Field Water Distribution Systems –
This practice applies water intermittently to furrows in seepage irrigation systems. It is applicable to agricultural producers that currently use gated pipe or flexible pipe (see above) to distribute irrigation water to furrow irrigated fields, and who have soil types that swell and reduce infiltration rates in response to irrigation. This practice increases efficiency and uniformity of delivery to the furrows (for instance, by reducing deep percolation of irrigation water near the head of the field), and reduces the potential for ponding and runoff. Water saved by switching to surge flow is estimated to be between 10 and 40 percent. The approximate range of savings is $20 to $25 per acre-foot. (Source – Best Management Practices for Agricultural Water Users, Texas Water Development Board, November 2013).

Soil Cultivation Techniques –
This practice incorporates the practice of spiking, slicing and core aerification of the soil to improve permeability, water infiltration, drainage, aeration and structure. Improved soil conditions can decrease the frequency of required irrigation.

Water Metering –
This practice involves the installation of water meters at pumping facilities and in critical locations throughout the irrigation system. Irrigation meters typically register a flow rate and a total volume. Information collected from meters can help detect leaks and calculate irrigation efficiencies.

<u>Tailwater / Surface Water Recovery</u>

Capturing Greenhouse Roof Run-off and/or Irrigation Water Runoff for Reuse–
This practice involves capture and reuse of rainwater, surface water runoff and/or irrigation water. This practice encompasses a wide variety of water storage techniques designed to capture and hold water for a period of time for later reuse. Storage may be in ponds, cisterns, or tanks. Conveying water to the storage facility may involve all or some of the following: rain gutters, down spouts, control structures/culverts, piping, spillways, and other water conveyance devices. This practice may involve a pump station, filtration system, and piping necessary to connect the collected water into the irrigation system. Additionally, these systems may include decontamination facilities to remove potential plant and human pathogens before the water is reused.

Tailwater / Surface Water Recovery and Reuse System –
This practice consists of establishing a reservoir(s) with a series of ditches and/or pipelines to collect and convey rainwater, surface water runoff, and excess irrigation water to the storage tailwater recovery reservoir(s) (typically below the grade of the irrigated land). Tailwater recovery and reuse systems typically include construction of the tailwater recovery and reuse pond, pump station(s), filtration system(s), underdrains, outfall structure(s), culvert(s), and piping to convey tailwater to irrigated fields for use and reuse.

Natural lakes within the region may also serve and be used, pursuant to applicable regulations, as a source of 'tailwater' for irrigation purposes. In containerized plant nurseries, plants can be grown on impermeable surfaces that collect almost all of the unused irrigation water and channel it into storage facilities. Growers using these systems may need to include decontamination facilities to remove potential plant and human pathogens before the water is reused.

Frost / Freeze Protection

Crop row covers/frost blankets–

Crop row covers/frost blankets are fabrics that are used to cover crops during frost/freeze events to help prevent damage to the plants. These products serve as weak insulators but reduce convectional heat loss, thereby creating a microclimate around the plant that is warmer than outside the cover. This practice can reduce or eliminate the need to use water during frost/freeze events. Crop row covers/frost blankets can be used if there is a sufficient labor force available to deploy the covers before freeze events and anchor them down so the wind does not blow them away.

Selective Inverted Sink –

Selective inverted sinks use an engine driven propeller placed parallel to the ground surface to push cold air that accumulates in low areas where crops are grown upward, creating a suction effect that draws warmer air at higher elevations down during a radiation frost/freeze event. The use of inverted sinks can prevent the application of water for frost/freeze protection during certain frost/freeze events.

Sprinkler Heads and Spacing Retrofits –

This practice employs the use of irrigation systems that more efficiently apply water for frost/freeze protection. The measure can include changing the sprinkler spacing to improve uniformity or changing the sprinkler type to decrease the rewetting intervals. Decreasing the rewetting interval allows reduced application rates.

Use Fog for Cold Protection in Greenhouses / Shade Houses –

In greenhouses or polyethylene film wrapped shade houses a low volume fog system can be used to effectively provide heat and reduce the heat loss from the soil and plant surfaces during periods where cold protection is required. The use of a low volume system reduces the volume of water required for crop protection compared to a mist or sprinkler system.

Wind Machines –

The movement of air by an engine driven wind machine mixes the warmer air above a temperature inversion layer with the cooler air at ground level during a radiation frost/freeze event. The use of wind machines may also require cold drains and prevents the need for water application during certain frost/freeze events. Wind machines are only effective during radiation freezes (calm wind conditions) where temperature inversions develop when cold air builds up near the ground (crop). Wind machines may obviate the need to use water for cold protection in central Florida during some radiation freezes but water may still be needed when advective freezes occur.

Agriculture Irrigation Efficiency Programs

Agricultural Mobile Irrigation Labs –

Mobile irrigation labs (MILS) are staffed by trained specialists who conduct field audits of agricultural irrigation systems. System design, maintenance, efficiency, distribution uniformity, and operations costs are all evaluated. Specific recommendations for efficiency improvements on reducing water applications, saving energy, improving yields, and resolving drainage and soil erosion problems are given to the user. (Handbook of Water Use and Conservation – Amy Vickers) For more than 16 years, partnership based MILs have been operating throughout Florida, and there are currently 11 agricultural MILs in operation. Agricultural MILs operate within all five water management districts and receive support from three of the WMDs, FDACS, and the USDA Natural Resources Conservation Service (NRCS). During the July 2012 – June 2013 reporting period, agricultural MILs helped Florida farmers conserve more than 1.1 billion gallons of water. (Florida AG Water News Volume 1/Issue 2 Fall 2013)

Environmental Quality Incentives Program (EQIP) –

EQIP provides technical assistance and financial assistance to implement conservation practices. Assistance is offered for a variety of practices that address natural resource concerns and deliver environmental benefits such as improving water quality, conserving water, reducing soil erosion, and creating wildlife habitat. EQIP is administered by the United States Department of Agriculture Natural Resources Conservation Service.

SWFWMD's – Facilitating Agricultural Resource Management Systems (FARMS) Program –

The FARMS Program is an agricultural BMP cost-share reimbursement program, available exclusively within the Southwest Florida Water Management District (SWFWMD). The program is a public/private partnership developed by the SWFWMD and the Florida Department of Agriculture and Consumer Services (FDACS) with qualifying BMP cost-share reimbursement rates up to 75 percent pursuant to Rule 40D-26, Florida Administrative Code (F.A.C.). The purpose of the FARMS initiative is to provide an incentive to the agricultural community within the SWFWMD, to implement agricultural BMPs that will provide resource benefits that include an emphasis on reduced Upper Floridian aquifer withdrawals, and/or improving water quality or natural-system functions within specified watershed. For more information on the SWFWMD's FARMS Program go to http://www.swfwmd.state.fl.us/agriculture/farms/.