Targeting Excessive Irrigation Customers to Maximize the Benefits of Smart Controllers

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Abstract. *Studies have shown minimal impact by smart irrigation controllers when installed without targeting over-irrigators. The objective of this research was to evaluate different methodologies for identifying residential over-irrigators. Two independent smart controller studies were conducted by utilities in Hillsborough (HCWRS) and Orange (OCU) Counties, Fla. In HCWRS, the cooperators qualified when irrigation was in the top 50th percentile of potable water users in the county and located in three densely-populated cities. In OCU, 112 cooperators across seven locations received smart controllers when frequently irrigating more than 1.5 times the gross irrigation requirement (GIR). Actual ratios of historical average irrigation to the GIR ranged from 1.45-2.37 in HCWRS and 6.04-8.33 in OCU. As a result, cooperators in OCU showed significant reductions in irrigation with a return on investment of 4-14 months compared to HCWRS with a payback period of 6.5-13.4 years. Using the GIR as a benchmark proved to be a better method than using utility-wide median irrigation application to target homeowners for smart controllers to ensure irrigation reductions.*

Keywords. GIR, ratios, residential irrigation, smart controllers

Introduction

Research studies have shown that smart controllers are most effective at increasing efficient irrigation practices when implemented by historical over-irrigators. However, most government or utility programs that focus on water conservation, such as rebate or trade-in programs, make smart controllers available to everyone indiscriminately. The objective of this work was to evaluate methodologies for identifying single family home utility customers capable of achieving significant benefits from implementing smart controllers.

Materials and Methods

Two independent irrigation studies were implemented in Hillsborough (HCWRS; Feb. 2009 to Jan. 2011) and Orange (OCU; Nov. 2011 to Oct. 2012) Counties, Fla. to determine the water conservation potential of smart controllers.

In HCWRS, 36 cooperators voluntarily participated in the study if they resided in one of the three selected communities, were in the top 50th percentile of county water users determined by Romero and Dukes (2010), and had irrigation systems with adequate performance. Twenty-one cooperators were outfitted with Toro Intelli-Sense™ TIS-612 (Riverside, CA) ET controllers (ET+Edu) that used WeatherTRAK ET Everywhere™ signal service (Hydropoint DataSystems, Inc., Petaluma, CA). The remaining 15 cooperators maintained their current irrigation practices (comparison). The ET controllers were programmed by UF-IFAS using default values except customized application rates by zone and irrigation system efficiencies.

In OCU, historical irrigation was determined from monthly billing records over a seven-year period by assuming indoor water use of 67 gpd and 2.2 persons per account. Estimated irrigation was evaluated against the GIR, thus creating monthly ratios (estimated irrigation/GIR). Volunteers were eligible when ratios were greater than 1.5 for at least 3 months per year for three consecutive years. There were 139 participants located across seven locations where each location had five treatments replicated four times except for one location where one treatment had three replications (19 cooperators). Two treatments consisted of Rain Bird ESP-SMT ET controllers and two treatments consisted of Baseline WaterTec S100 SMSs. Two treatments, one for each technology, were installed using methods determined solely by the installing contractor without UF-IFAS intervention. The remaining two technology treatments included UF-IFAS training for the contractor prior to installations, site-specific programming of the smart technology, and cooperator education. The final treatment was a comparison treatment that did not receive intervention.

Historical billing records for HCWRS (7 years) and OCU (5 years) were provided to estimate historical irrigation from combined indoor and outdoor water use by subtracting estimated indoor water use. In both studies, the average monthly indoor water use estimated for each participant during the study period was applied to the corresponding historical month.

The GIR was calculated by multiplying the net irrigation water requirement (IWR_{net}) by a scheduling multiplier (SM). The IWR_{net} is defined as the amount of irrigation required to increase soil water storage to field capacity (FC) (IA 2005). The IWR_{net} was determined from mass conservation of soil water content (IA 2005):

$$IWR_{net} = PWR - R_e \quad (1)$$

The PWR is the plant water requirement (in.) and R_e is effective rainfall (in.). The IWR_{net} was accumulated daily, but was applied only on days when the soil water level fell below management allowable depletion (MAD), calculated as 50% of the difference between FC and permanent wilting point (PWP) (IA 2005).

The PWR equals the plant-specific evapotranspiration (ET_C) using the following equation (Allen et al. 1998):

$$ET_C = K_C * ET_O \tag{2}$$

The ET_O was calculated by the American Society of Civil Engineers – Environmental and Water Resources Institute (ASCE-EWRI) standardized ET equation (ASCE-EWRI 2005). The K_C values were updated monthly for turfgrass ranging from 0.45 (December-February) to 0.90 (May) (Jia et al. 2009).

Effective rainfall was the portion of total daily rainfall that filled the soil storage capacity after PWR was taken into account. Rainfall that exceeded the soil storage capacity was lost due to surface runoff or deep percolation.

A scheduling multiplier (SM) based on the average uniformity of the irrigation system was used to convert IWR_{net} to GIR. The SM was determined from the DU_{lq} using the following equation (IA 2013):

$$SM = 100/(38.6+61.4*DU_{lq}) \tag{3}$$

The calculated DU_{lq} values for each participant were used for the HCWRS study whereas an estimated average of 0.674 was used for the participants in OCU.

Statistical analyses were performed using Statistical Analytical Systems (SAS) software (Cary, NC). The ratios were analyzed using the glimmix procedure and comparisons were made using the least mean square differences by treatment. Significance was determined at a 95% confidence level.

Results and Discussion

The ratios calculated for HCWRS, ranging from 1.45 to 2.37, were much lower than the ratios calculated for OCU, ranging from 6.04 to 8.33, due to higher amounts of irrigation applied in OCU compared to HCWRS. Though the 95% confidence intervals for the ratios in HCWRS were above 1, the cooperators were not good candidates for smart controllers.

To determine the return on investment for a smart controller, it was assumed that the purchase and installation of a SMS or ET controller was $400 and $600, respectively, based on communications with contractors across Florida. Additionally, the landscape area was assumed as 5,000 ft^2 for this analysis. In HCWRS, an annual return of

$45.13, $60.39, and $94.42 in Riverview, Valrico, and Apollo Beach, respectively, was observed from implementing an ET controller. Based on these totals, it would take 6.5 to 13.4 years to profit from the ET controller. Annual savings were much higher in OCU than the HCWRS study, ranging from $549.22 to $1,572.78. This resulted in more preferable rates of return with payback periods ranging from 4 months to 14 months.

Conclusion

Partitioning utility customers based on the median estimated irrigation did not produce over-irrigators since most of the excessive irrigation occurs by customers in the 95th percentile. Ultimately, the gross irrigation requirement combined with an irrigation evaluation proved to be a better method than using utility-wide median irrigation application to target homeowners as candidates when focused on reducing the overall potable water demand.

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