Abstract

The complexity of scheduling irrigation can be greatly reduced by the use of publicly available computer programs. However, irrigation scheduling is more complicated in humid regions than arid locations, due to factors such as cloudy weather, rainfall, and temperature swings caused by the movement of weather fronts. Weather conditions vary greatly in humid regions from year to year, and even within a year, and the variability must be accounted for in the scheduling program. The Arkansas Irrigation Scheduler has been in use for over twenty years and is currently used in Arkansas and surrounding states. The current version was released in 2000 and a new release is planned for 2006. The new version will maintain the objectives of the earlier releases, except that it will be field-, rather than system-based. The change allows the users to view information on more of their fields at one time and group the fields however they feel most suitable. Drip irrigation scheduling will be added for both surface and subsurface systems. While new crop coefficient functions will not be included initially, they can be added as appropriate. Using the program to properly schedule irrigation can save energy and therefore money by reducing unnecessary pumping, and help to alleviate water shortages being experienced in many agricultural areas.

Introduction

The complexity of scheduling irrigation can be greatly reduced by the use of publicly available computer programs. Henggeler (2002) summarized eight programs developed in locations ranging from Arizona to North Dakota and varying greatly in complexity and input requirements. However, not all programs work equally well in both arid and more humid climates. Irrigation scheduling is more complicated in humid regions than arid locations, due to factors such as cloudy weather, rainfall, and temperature swings caused by the movement of weather fronts. Weather conditions in humid regions vary greatly from year to year, and even within a year, and the variability must be accounted for in the scheduling program.

One of the programs discussed by Henggeler (2002) was the Arkansas Irrigation Scheduler (Scheduler). The Scheduler has been in use by farmers in Arkansas and surrounding states for over twenty years and a new version will be released in 2006. The updated version will include improvements to incorporate knowledge gained since the 2000 release of version 1.1w, to feature more intuitive operation similar to other Windows-based programs, and to be more universally applicable, rather than just aimed at users in Arkansas and surrounding states.

Arkansas Irrigation Scheduler

The Scheduler was developed in the 1970s and early 1980s under the leadership of Dr. James Ferguson to aid Arkansas farmers in managing irrigation. Arkansas producers were just beginning to irrigate their crops, rather than depending solely on rainfall to meet the crop's water needs. In fact, during the years 1972 through 1981, the first ten years with separate records collected for irrigated and nonirrigated crops in Arkansas, an average of only 8% of the soybean and 14% of the cotton crop was irrigated (NASS, 2005).

Like many scheduling programs, the Scheduler uses a water-balance approach to scheduling irrigation, similar to managing a checkbook. The system balance represents the soil water deficit (SWD), the difference between the soil's existing moisture content, summed over the rooting depth, and the moisture content of the soil at its well drained upper limit (~24 hours after surface water was removed). Deposits to the system include rainfall and irrigation. Withdrawals from the system include evapotranspiration (ET), runoff, and deep percolation below the root zone. The program doesn't attempt to estimate runoff; instead the user is asked to input the effective rainfall, or the amount in excess of runoff. Deep percolation is considered negligible when the SWD > 0. Rooting depth is not used explicitly in the program, but is implicit in the choice of a maximum allowable SWD. More detailed descriptions of the program were presented by Cahoon et al. (1990) and that information will not be repeated here. Rather, this report will deal with how the version of the program planned for release in 2006 will be different from previous versions.

The program has gone through many changes as both knowledge and personal computing power have advanced. The earliest versions were mainframe-computer based (Yar, 1984), since personal computers (PCs) were somewhat rare and not very powerful at that time. The initial program was only for center pivot systems. Later versions included support for towable center pivot systems (Edwards, 1986) and eventually furrow and flood irrigation (Cahoon et al., 1990). The current (2000) version also includes support for graded border irrigation.

The original PC version of the program was written in BASIC for the Radio Shack TRS-80 computers (mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture or University of Arkansas) in many University of Arkansas Cooperative Extension Service (CES) and some farm offices. Several updated versions were released by CES for the MSDOS™ operating system, and the most recent version was written for Microsoft Windows™.

Cahoon et al. (1990) reported the five objectives for their program were: 1) to be user friendly and easily operated; 2) to require minimal input data; 3) to be applicable to mid-South climatological conditions and crops; 4) to be system-based as opposed to field-based; and 5) to be useful as a prediction tool, as opposed to a monitoring tool. While increases in computing power have reduced the need to be system based, four of those objectives still apply.

Changes for the 2006 Release

Early in 2005 a group of program users met to discuss ways to improve the program for the next release. One commonly heard comment was that the program should operate similarly to other Windows-based programs, making it easier for new users to learn to operate the program. Therefore, many of the changes were intended to make the program more user friendly (obj. 1).

The program was developed for Arkansas producers, and much of the funding for developing and supporting the program was provided by Arkansas soybean producers through their checkoff funds. However, producers in the states surrounding Arkansas also use the program and many researchers use the program as well. In the past, producers or researchers with extensive weather data were only able to use the maximum daily temperature and rainfall data and required to select one of six locations (Stuttgart, Keiser, and Hope, Arkansas; Jackson, Tennessee; Stoneville, Mississippi; and Calhoun, Louisiana) most similar to their own location for estimating ET. Most researchers and some nearby states, including Louisiana and Missouri, had electronic weather networks that provided more extensive weather data than was available to most Arkansas producers. The new release will allow users to input a reference ET directly, rather than having the program estimate one. Those with limited data can still allow the program to estimate ET in the same way as before. Therefore, while only minimal input data is still required to use the program (obj. 2), the changes will allow the user to take advantage of the data available when it exceeds the minimum required.

While the program will be applicable to more areas than before, it is still intended primarily for use in humid climates (obj. 3). Wet soil conditions typical of winter and early spring simplify the choice of a starting SWD. In addition, small errors that accumulate over time from the use of limited weather data will usually be erased by rainfall.

Recent versions of the program have changed from system-based to field based (obj. 4). In the early versions, computer memory and storage restricted the program to only consider a small number of fields. A representative situation was selected as a four-field system, representing quadrants of a stationary center pivot field, halves of two towable center pivot fields, or four fields sharing one well for surface irrigation. Recommendations were made for when to irrigate each of the fields in the system. More powerful PCs allow many more fields to be considered simultaneously. Being able to view the soil moisture status of most or all of the fields on a farm at the same time was believed to be more advantageous than retaining the system base. The user could then choose to group the fields in whatever way best fit the situation.

The program has kept its utility as a prediction tool, rather than just a monitoring tool (obj. 5). The predictive capability of the program is one of its most important assets under mid-South conditions, where multiple crops are often irrigated from the same water supply. In addition, irrigation decisions are often coordinated with pesticide applications or other field operations.

Support for two new types of irrigation systems will be included in the new release: surface and subsurface drip. The surface drip routine will be similar to the center pivot routine, except that the assumed application efficiency will be 95%, whereas 90% was assumed for center pivot systems (Cahoon et al., 1990). The subsurface drip routine will also assume 95% efficiency, and assume no soil surface wetness associated with irrigation.

There are currently no plans to change the crop coefficient functions in the program., However, considerable research is being conducted on crop coefficients and new functions can be added as improvements are developed for the currently included crops (cotton, soybean, corn, milo), or if schedules are needed for additional crops.

Even with all of the changes to the Scheduler, users must remember that many things can affect the accuracy of the program output. Considerable runoff can result from thunderstorms or from too high of application rates with a center pivot. Care must be taken when estimating effective rainfall or the actual irrigation amount. With furrow irrigation, soil crusting, irrigating every other middle, or irrigating a field with appreciable slope may result in less than saturated conditions following irrigation, even though the assumption in the program is SWD = 0 (Cahoon, 1990). Another assumption in the program is no standing water (i.e., all rainfall or irrigation applied in excess of the SWD will run off the field). Standing water can cause the soil to remain saturated for several days, stressing the crop and continuing to affect water use after the standing water is removed. Estimates for water use in the program are based on a healthy, well watered crop. A crop that has been drought stressed or experienced oxygen stress from standing water may never recover to the expected water use rate.

Beginning with the 2006 release, an internet version of the program will be available, where the user is always assured of having the latest version and doesn't have to bother with installation of the software. The internet will continue to be the means for program distribution for those who want a stand-alone program. A voluntary registration will continue to be used to maintain a user list in case programming bugs are discovered or later releases become available.

Finally, the new release of the program will be applicable to more areas than before, and will offer improvements for users already familiar with the program. Using the program will aid producers in determining the optimum irrigation schedule for their situation. Properly scheduling irrigation can save energy and therefore money by reducing unnecessary pumping. In addition to saving money, however, reducing unnecessary pumping can help to alleviate water shortages being experienced in many agricultural areas.

Summary

The Arkansas Irrigation Scheduler has been in use for over twenty years and is used in Arkansas and surrounding states. The current version was released in 2000 and a new release is planned for 2006. The new version will be field-, rather than system-based; otherwise it maintains the objectives of the previous releases. The change allows the users to view more of their fields at one time and group the fields however they feel most suitable. Other changes will make the program easier to learn, allow the user to take advantage of more extensive weather data if it is available, make the program applicable to more areas than before and include support for drip irrigation. While new crop coefficient functions will not be included initially, they can be added as appropriate. . Using the program to properly schedule irrigation can save energy and therefore money by reducing unnecessary pumping, and help to alleviate water shortages being experienced in many agricultural areas.

References

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