Implementation of the Mississippi Irrigation Scheduling Tool in a dynamic web-based format

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The Mississippi Irrigation Scheduling Tool (MIST) has been developed to provide a daily calculation of water balance for row crop production. This daily calculation incorporates field specific data on soil type, tillage depth, row spacing, and crop type to make a recommendation on crop water needs. Weather data is automatically downloaded from national and regional databases and used to calculate daily evapotranspiration rate using the Modified Penman-Monteith equations. The first goal of MIST was to make it more accessible to the users. To do this, MIST was implemented as a web application, developed with Java and HTML. Using a web application eliminates the need for the user to download, install and update software. The main difficulty with a web application is making sure that every browser is displaying the web pages correctly since each web browser can interpret code differently. Incompatibilities between web browsers were observed a few times; one of these occurrences was with the font that was being used. Potential incompatibilities are determined by testing the system on multiple web browsers and platforms, though updates in these systems may present problems in the future. All the data is stored within a MySQL database, which currently contains twenty tables each having between three to twenty data columns depending on the data stored. Database security is maintained by restricting server connections to local only. One of the more common SQL attacks is done through SQL injection. Prepared statements are used to prevent these types of attacks. Most of the data are stored in plain English text with a table's data column. Passwords are converted to a MD5 checksum. MD5 checksum is a cryptography based algorithm that allows the storage of data without knowing what the data actually is. This provides security in the event someone is able to obtain access to the database—sensitive information will not be accessible. There are a few different types of user ranks within the interface: admin, manager, consultant, company, and farmer, with each user rank assigned different permissions. To assist in the tedious task of setting up each field within the farm, farmers are allowed to select the border of their field with Google maps. Implementing MIST has been full of challenges and decisions that will be discussed in this paper. Given the widespread adoption of tablets and smartphones, a web application provides equal access to any device that has access to a web browser.

INTRODUCTION

Expanding reliance of crop producers on ground water for irrigation has begun to deplete the alluvial aquifer in Mississippi (Powers, 2007). Additionally, the water resource needs of crop production in the humid mid-South are not known. Accurate, easy to use tools, developed and calibrated for the humid, high rainfall environment are needed that allow crop producers to schedule irrigation based on crop need. Knowledge on crop water requirements and water resources is critical to develop practical, efficient water management guidelines for crop production. Moreover, information on agricultural water use and requirements is needed to develop scientifically sound water management policies within the region and the state.

Irrigation scheduling tools have been successfully developed and delivered to producers in many states. The success of online irrigation scheduling tools has advanced the access and use of web-based systems, and demonstrated their usefulness in crop management (Hess, 1996; Scherer and Morlock, 2008). Advantages of web-based decision support tools include: independence from operating systems; no need to install software; and accessibility on a wide range of mobile devices (including mobile phones). Challenges to implementing these tools include the need to address browser compatibility, with each browser interpreting code slightly differently; differences in features supported by different browsers; and compatibility issues even between browser versions. Many different browsers and mobile devices, and the continued development and modification of current systems, means web-based code must respond and adapt to remain viable. However, the increasing use and ease of use of these mobile devices offers a great opportunity to increase the access and use of decision support tools for crop production.

The Mississippi Irrigation Scheduling Tool (MIST) is designed to be an on-farm decision support tool to assist farmers in knowing when and how much to irrigate using a water balance approach (Bronner, 1992; Sassenrath et al., 2013). Water balance models used for scheduling irrigation calculate the soil water balance by summing the previous day's soil water, less crop water use, plus rainfall or irrigation. The MIST implements the latest knowledge of crop water management into a user-friendly, readily accessible web-based interface.

METHODS

Java is the main coding language used to implement the MIST. HTML is used to develop the user interface. Cascading style sheets (CSS) are used with HTML to change how the page is displayed to the user. JavaServer Pages (JSPs) are used for the website integration of HTML and Java. MySQL is used as the database to store the input data and calculations. Currently, 21 tables are used to hold the data and calculations. Additional tables can be added to accommodate increasing data or computational requirements.

The inputs to the system include weather data (sunlight, temperature, relative humidity, and wind speed), soil data (available water holding capacity and textural characteristics), rainfall, and data input by the end-user (Figure 1). The data required from the user includes field-specific information such as field boundary, crop type, planting date, and irrigation water applied.

The automated data and user-level input data are used to parameterize the system on the main server. The user accesses the system through a desktop or mobile device. Daily evapotranspiration rates are calculated, and daily soil water balance information is determined to decide irrigation needs.

RESULTS AND DISCUSSION

While making MIST a web application allows it to be easily accessed on multiple devices, extensive testing is needed to make sure the site appearance is consistent for each device/browser. Each browser – such as Internet Explorer, Chrome, or Firefox – has its own rules on how code is interpreted. This means that a table being displayed properly in Chrome might not even look like a table in Internet Explorer. The design of each page must be tested thoroughly on each browser and device to verify an equal experience upon each browser and device. Additional concerns that were addressed in the design and implementation of the user interface include security and protection of sensitive information. Passwords are generated using an MD5 HASH procedure.

After login, the user establishes individual fields. Fields are selected by highlighting an area on a map (Figure 2). A name is given for the field, and field information such as crop type, tillage, and planting date are entered. Initial information on soil type is chosen by the user. Alternatively, field boundaries can be imported as shape files in a predefined format.

Once the user inputs field, crop and soils information on the input pages, and the weather information is updated, the soil water balance is calculated and soil water deficit presented on the calendar page. Notifications and warnings of soil water deficit and field conditions are given in both symbol and color images for clarity (Figure 3). The information on individual field irrigation needs is displayed in a calendar format, with colored icons assigned to each field to indicate water deficit status.

After picking a field, the user will see the current month and the water deficit status for each day of the current month. The month and year that the calendar is displaying can be changed at the top of the page. By hovering over or clicking a specific day, the user can view the current water balance of the select field as well as the amount of rainfall and irrigation applied, if any. The user can adjust the rainfall or irrigation amount by clicking on the date of application. These changes will be considered on the next recalculation of soil water deficit. Three colors are used in the date blocks of the calendar to quickly give the user an idea of the water deficit status. A slightly darker tan than the calendar's background indicates future days during which soil moisture has not yet been calculated. A blue color indicates the water deficit in the field is within the acceptable boundaries. A red color is used to indicate field soil moisture has fallen below the established Maximum Allowable Depletion (MAD).

CONCLUSION

The decision support tool developed in this research project will help growers manage water resources. The system is intuitive, easy to use, accessible on a wide range of commonly used mobile devices, and requires minimal time to set up and run. By delivering the system through the web, the end-user will not need to install and upgrade the decision support tool. The utility of irrigation scheduling tools can be further enhanced by integrating them with other management systems, such as online pivot monitoring systems (WagNet, AgSense, LLC).

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DISCLAIMER

Mention of a trade name or proprietary product does not constitute an endorsement. Details of specific products are provided for information only, and do not imply approval of a product to the exclusion of others that may be available.

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Figure 1. Implementation design of the Mississippi Irrigation Scheduling Tool - MIST.

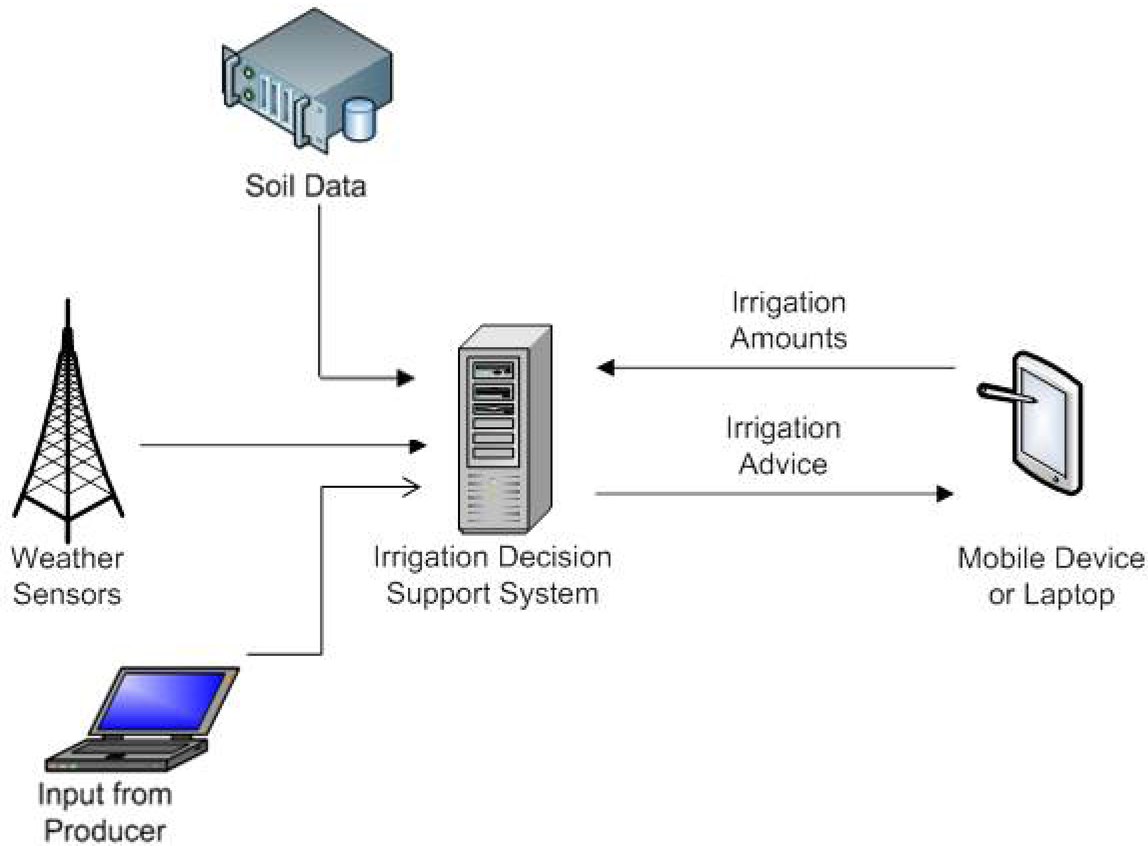

Figure 2. Setup of fields and initial data input in the Mississippi Irrigation Scheduling Tool - MIST.

Figure 3. Information on soil water deficit for May 20 is displayed in a calendar view in the Mississippi Irrigation Scheduling Tool. Selecting a specific date gives detailed information on the soil conditions, allowing the end-user to update information on rainfall received or irrigation water applied. The color of the date in the calendar block indicates where soil water deficit is good, or has exceed the Maximal Allowable Depletion (MAD).