Information Sheet

5.4 Irrigation Scheduling Toolbox

Irrigation scheduling is the practice of deciding when and how much water to apply. Poor irrigation scheduling can result in either under-irrigation, leading to water stress and reduced yields, or over-irrigation which leads to misuse of water and electricity resources, leaching of expensive fertilisers, erosion of the top soil and anaerobic soil conditions resulting in yield reductions. A number of tools are available in the **irrigation scheduling toolbox,** which range from direct measurement of soil water content to weather-based methods for estimating crop water use and soil water status. This information sheet provides a brief overview of the most widely used irrigation scheduling tools in the sugar industry. The decision tree shown in Figure 1 will guide you through the process of choosing the most appropriate tool for your specific situation.

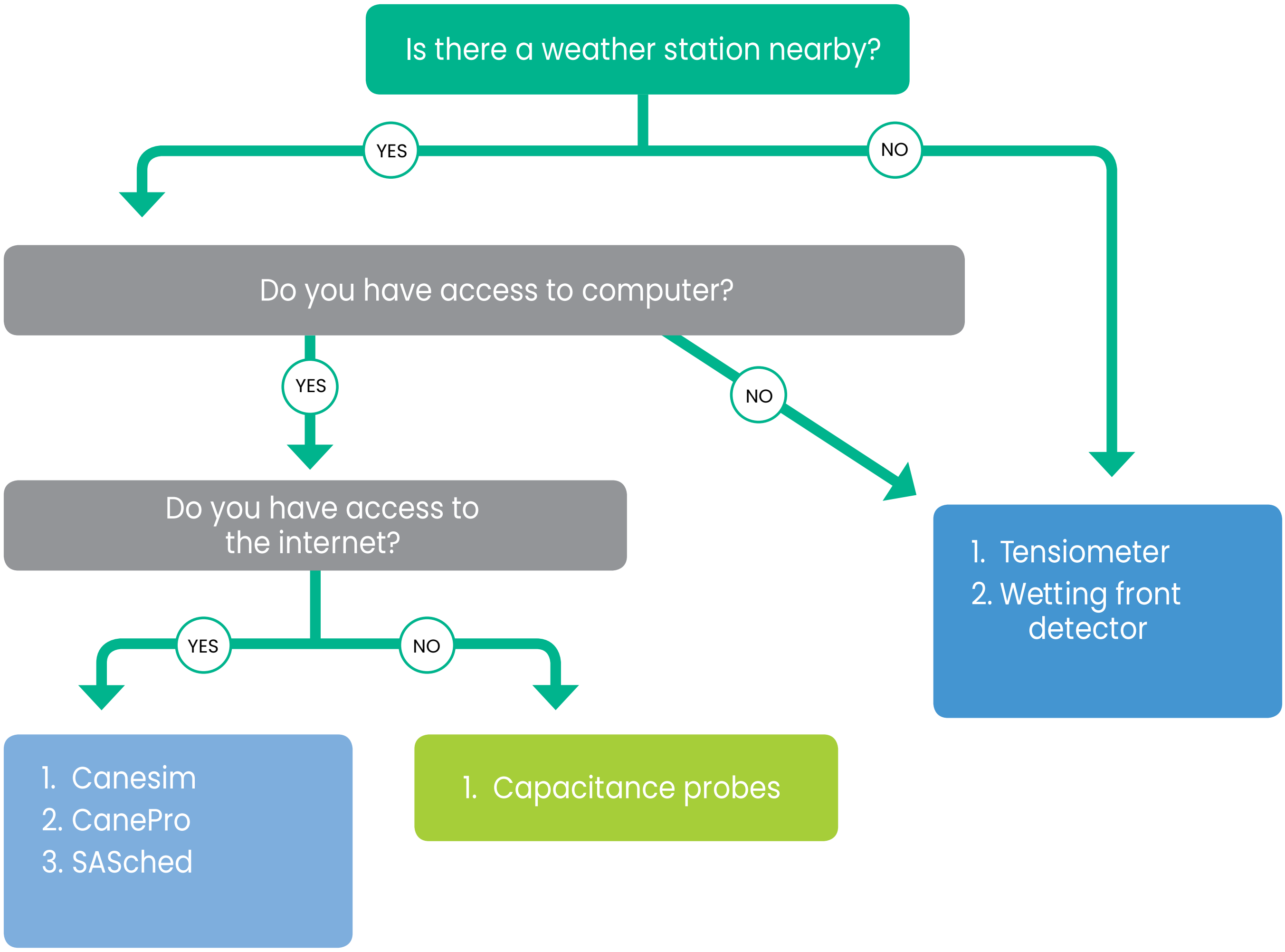

Figure 1: Decision tree for choosing the most appropriate irrigation scheduling tool.

Direct measurement of soil water content

Continuous logging capacitance

Probes are permanently installed in the field and can measure up to six depths simultaneously. Automatic rain gauges record rainfall and irrigation. Depending on the manufacturer, data is downloaded via wireless communication with a roaming data logger, radio telemetry or GSM cell phone network. Data and graphics are easily accessible either through desktop software or the internet.

User friendly software, ease of access to the data and the real-time nature of the data (hourly or half hourly) have made these probes very popular amongst growers.

▲ Figure 2: Capacitance probe.

Tensiometers

Tensiometers indicate the suction force required by plant roots to extract water and is a direct measure of the availability of soil water for plant growth. A reading of 0 kPa will indicate saturation and the higher the gauge reading, the drier the soil.

A tensiometer station normally consists of tensiometers installed at 30 cm, 60 cm and 90 cm depths. The deeper instrument acts as a control to guard against over-irrigation. Tensiometers are relatively cheap, but require regular servicing to top up water and remove air bubbles.

▲ Figure 3: Tensiometer.

Wetting front detectors

This instrument is a simple funnel shaped tool that is buried in the root zone. The funnel concentrates water into a chamber which triggers a mechanical float (visible aboveground) thereby indicating when water has reached the desired depth. Wetting front detectors can therefore inform when to stop irrigating, but not when to start up again.

Detectors should be used in pairs; the shallow detector should respond to most irrigation events and the deeper detector should respond occasionally. Wetting front detectors are relatively cheap and easy to install.

▲ Figure 4: Wetting front detector.

Placement

Correct placement of soil water monitoring devices are critical. Devices should be placed in a representative position within a field and preferably in more than one position. For overhead irrigation, devices can be placed in close proximity to the cane row (about 15 to 30 cm). For drip irrigation, the placement in relation to the emitters is more critical. As a guide, devices should be placed ¼ of the emitter spacing away from the emitter and of emitter spacing away from the line. It is highly recommended that a trench be dug to look at the lateral water movement and root distribution in order to determine correct placement of soil water monitoring devices. It is always desirable to place a rain gauge at each measuring position not only to measure the exact application amounts, but also to act as a marker.

Indirect estimation of soil water content

Soil water budgeting spreadsheets

Soil water content can be estimated by accounting for additions or profits (rainfall and irrigation) and removal or losses (crop water use) on a daily basis using a basic spreadsheet. Irrigation is scheduled once the estimated soil water content reaches a predetermined threshold level. A good example of such a water budget system is the SASched spreadsheet.

Crop models

With the advent of automatic weather stations, crop models such as Canesim and Canepro are now widely used to automatically calculate the daily crop water use and soil water budget. These models use weather data and basic information on the soil, crop and irrigation system to keep track of the soil water balance automatically and to generate irrigation scheduling recommendations. In addition, crop models are capable of accurately predicting final cane and sucrose yields. A user friendly version of the MyCanesim® model is available on the SASRI website (www.sugar.org.za/sasri). Choose 'Çrop Resources' from the menu.

Remote sensing

An exciting new development is the use of remotely sensed data via satellite or unmanned aerial vehicles (UAVs) to estimate crop water use (and biomass production) on a high resolution and near real-time basis. High costs and other practical limitations are, however, currently limiting the wide application of this technology.

Accuracy of irrigation scheduling depends largely on the accuracy with which the available amount of water in the soil can be determined. Accuracy of irrigation scheduling can be increased vastly by combining different methods, for example scheduling with a crop model such as MyCanesim® and also monitoring soil water content of the same field with a capacitance probe. Knowledge of your soils and their total available water (TAW) is a key component of successfully implementing accurate irrigation scheduling. While accuracy is important, any scheduling method is better than not scheduling at all.

Choosing an appropriate product or service provider

Because of the wide array of products, and with so many different commercially available systems, it can be challenging to select one that best suits your specific needs and budget. The set of guideline questions presented below will help you assess whether the irrigation scheduling service providers and products meet your needs and are of an adequate quality.

Table 1: Key questions to ask before deciding on a specific irrigation scheduling tool or service provider

1. What does the product/service entail?	
Data/ advice conveyance:	o Is the data available via direct download to local PC, via web interface on central server, or delivered on PC or smart phone, via web or radio signal?
Level of involvement:	o Can the irrigation advice be applied immediately (when, how much and where to irrigate) or is additional post processing required (soil water deficit calculation)?
Format and frequency of advice:	o Is soil water status reported in index values (not calibrated) or in volumetric units (calibrated)? o Is advice provided on hourly, daily or weekly basis and how does this fit in with the irrigation system being used? o Is weather data and/or irrigation scheduling computer models also used in the advice to make a forecast?
2. What is the quality of the equipment and software?	
Durability:	o What is the typical life span? o Is there some kind of guarantee? o How much of it is exposed above the ground? o What is expected from the user regarding maintenance and care?
Sensors:	o What kind of soil moisture sensor is used and can rainfall/ irrigation also be measured? o Sensor specifications, number of sensors, sensor depths, accuracy and precision?
Battery:	o What type? o How long does battery last and what is the cost of replacement? o Who replaces it?
Data logger and transmission:	o Data logging frequency and data transmission frequency? o Data transmission/download method (cell, local radio, Bluetooth/wireless)?
Software:	o How easy is the software package to use? o What are the initial and annual cost of package?
3. Installation and after sales service:	
Method:	o How are the probes installed (placement in relation to cane row, irrigation applicators, soil variation, depth, angle)? o What quality control criteria is used? o How often is the hardware checked for functionality and accuracy (including recalibration if required)?
After sale service:	o What after calibration procedures are done, when and how often? o What is the agreement regarding maintenance and repairs? o How long to respond to a query and what are the call out fees involved?
Cost:	o How much is the initial cost of equipment, software, transmission costs (air time or radio licence), cost of repairs, maintenance costs, data costs, annual licence fee, etc.

4. **Is the company reputable?**	
Local or International:	o Who and where is the owner/manufacturer of the company, probes, data transmitters and software?
Address:	o Do they have a web presence? o How long have they been in existence? o Do they have local representatives? o Are they registered with SABI?
References from other users:	o Any feedback from current users?
Consultants:	o Are there local consultants for the company or does someone have to travel far from head office? o What is the training and knowledge (ET and its factors (weather and canopy), soil water relations, irrigation systems, agronomy and crops, probe principles) of the local rep/agent and company staff? o How easily contactable are they?
Sugarcane knowledge:	o Does the company have knowledge/ done previous work in sugarcane?
5. **Other considerations:**	
Theft or vandalism:	o How conspicuous is equipment (poles, solar panels, rain gauges etc.) in the field?
Protection during burning and harvesting:	o What measures are taken to protect the probes from damage during cane burning and harvesting operations? o Can the instruments be moved easily when required?
Communication:	o Is there good coverage by one or more cell phone provider across the farm? o Are there any obstructions such as small hills or large trees between fields and the office that could limit telemetry based systems?

Francois Olivier (Scientist:Irrigation)

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