Underground spies

Sensors monitor and report soil moisture levels, helping growers make better informed irrigation decisions.

By Vicky Boyd
Editor

Soil moisture sensors help growers get to the root of the problem of under- or over-irrigating by monitoring and reporting underground moisture content. Although not a silver bullet, these sensors should be viewed as one of several tools that can provide data on which to make better informed irrigation management decisions.

The actual water savings from sensor use depends on the crop, the soil type and the weather during a particular year. One of the biggest benefits is risk management by helping growers determine when and how much to irrigate and when they can safely stretch or eliminate an application because of adequate soil moisture.

“But we do generally see an increase in water-use efficiency by using sensors independent of a wet or dry year,” says Wesley Porter, University of Georgia Extension precision ag and irrigation specialist based in Tifton.

He says it’s difficult to estimate how many growers in his state are using soil moisture sensors to gauge irrigation, although a U.S. Department of Agriculture National Agricultural Statistics Service survey 3 years ago showed about a 10 percent adoption rate.

“That’s probably low in some areas and high in other areas throughout the state of Georgia,” Porter says. Based on his experience, he says adoption rates are as high as 50 to 70 percent in areas where consultants promote them as part of a suite of services.

“If you have a pocket that has a good consultant, then all of a sudden you’ll see a lot of farmers getting their (irrigation) recommendations from them,” Porter says. “The biggest level of adoption in our state is through our consultants, and it’s just because of the time requirements” to read the sensors and determine irrigation recommendations.

Farmers frequently find it’s easier to pay the consultant a small additional fee to monitor soil moisture levels than to manage it themselves, he says.

From basic to Cadillac models

For growers just starting out with soil moisture monitoring, he recommends going with either Watermark sensors or capacitance sensors, such as the Decagon EC-5. Each has benefits and drawbacks.

Watermark Granular Matrix sensors from Riverside, Calif.-based Irrometer Co. Inc., involve two electrodes imbedded in a thumb-sized sensor covered with a stainless steel mesh sleeve. Two electrodes protruding from the top allow users to hook them to a hand-held meter to read the soil matric potential, which indicates the energy the plants must expend to extract water from the soil.

As the soil water content increases, resistance between the electrodes decreases and vice versa. But they may not perform well in very sandy soil because of porosity and a lack of sensor-to-soil contact.

A set-up, which includes three sensors and a hand-held meter, costs about $400.

Capacitance sensors read the volume of water in the soil. The Decagon EC-5 capacitance sensor runs about $100 apiece, not counting the datalogger to record the readings.

On the other end of the spectrum are automated remote weather stations that include a soil sensor component. Depending on the model, these can be accessed via smartphones or desktop computers. Prices start at about $1,500 up to more than $3,000 per unit. In addition, they still require visits to the field to ground truth the data and may carry a subscription fee for data transmission, Porter says.

Sensor placement

In a field with uniform soil type, Porter recommends placing a sensor set-up in the part of the field most representative of the entire irrigated area of the field. The location shouldn’t be in a low or high spot, nor should it be near a road or parking area just because it is convenient.
Agricultural economist Marshall Lamb and plant physiologist Diane Rowland check crop water-use sensors used in irrigation scheduling, methods developed at the ARS National Peanut Research Laboratory in Dawson, Ga.

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\textit{Wesley Porter}

But many fields may have multiple soil types with differing irrigation needs. Optimally, growers would install sensors in each of the soil types and use variable-rate irrigation to match water application to soil characteristics.

Realistically, Porter says, most growers don’t want to step up the management that accompanies variable-rate irrigation and prefer a flat-rate program with one set of sensors.

Take a 100-acre field, for example, with three soil types; one type occupies 50 acres and two others represent 25 acres each. In this case, Porter says, the grower would place the sensor in soil representing the largest portion of the field but would run the risk of over- or under-irrigating the other soil types.

Placement of individual sensors within a set also depends on the crop and rooting depth. Although some crops may have a deep tap root, the bulk of the root mass that mines the most water is in the top few inches of soil.

For peanuts, he recommends placing three sensors at 4-, 8- and 16-inch depths.

For corn and cotton, he recommends three sensors placed at a 6- to 8-inch depth, 12- to 18-inch depth, and 24-inch depth. And for soybeans, he recommends three sensors at 6, 12 and 18 inches deep.

\textbf{By the numbers}

But soil moisture data are just part of the equation. By factoring in weather forecasts, plant growth stage and predicted evapotranspiration rates, users then determine how much water to apply in the coming days to compensate for expected water use.

To make calculations easier, several online tools and smartphone apps are available.

IrrigatorPro, a Web-based tool found at \url{http://irrigatorpro.org/farm/}, calculates how much soil moisture is available compared to the water needs of the crop based on growth stage. It supports peanuts, cotton and corn.

Similar to IrrigatorPro, the University of Florida’s Peanut Field Agronomic Resource Manager, or PeanutFARM, is designed just for peanut growers. It can be found at \url{http://peanutfarm.org/}.

PeanutFARM provides adjusted growing degree-days calculated by using upper and lower daily air temperatures, plus the amount of water the crop receives from rainfall and irrigation, to predict crop development.

That information, along with weather data automatically downloaded from state networks or manually inputted by the grower, is used by program to help schedule irrigation by estimating crop canopy cover and daily water use.

Additional irrigation smartphone apps, including the SmartIrrigation Cotton App, are available for free download at \url{http://smartirrigationapps.org/}. A similar SmartIrrigation app for soybeans is in the works.
Clemson University has been granted a blanket license by the Federal Aviation Administration to fly unmanned aerial vehicles, also known as UAVs or drones, throughout the United States.

The “Blanket Area Public Agency Certificate of Authorization” expands a previous FAA license that allowed research engineer Joe Mari Maja to fly a UAV for research purposes at limited locations in South Carolina. Now, Maja can fly a small UAV weighing less than 55 pounds anywhere in the country. The new license also allows the university to register more Clemson employees as pilots.

Maja is using UAVs to monitor crop health and gather data to improve farming productivity by letting growers know precisely when and where to water, fertilize or spray.

A sensor engineer, he is fitting his UAV with “intelligent agri-ronics devices”—sensor-based technologies that collect a wide range of crop data.

UAVs allow for much quicker crop monitoring; a craft can analyze a 10-acre field in less than five minutes, work that used to take a person days or weeks to complete, he says.

“I believe the applications for this are very diverse,” says Maja, who has a background in computer engineering. “UAV is a game-changer in precision agriculture.”

Precision agriculture reduces waste and optimizes farm equipment and materials by targeting the amount and locations of water, fertilizer and chemicals to the specific areas of a field where products are needed. Maja’s work is particularly important in fields with high degrees of soil variability.

Last year, Clemson’s Edisto Research and Education Center in Blackville, S.C., opened a high-tech sensor laboratory. It allows Maja and his colleagues to develop precision-agriculture technologies that once took weeks or even months to build, test and refine.

Working with Clemson entomologists, agricultural engineers and agronomists, Maja is building circuit boards and sensors he designed to be used in fields, on agricultural equipment or on his UAV.

With the new machines installed at the Edisto REC, Maja can build a variety of interface boards, controller system boards and connected products that allow technologies to collect and exchange data.
PLUG-INS WILL HELP YOU ADAPT TO MYRIAD FILE FORMATS

If you collect data from planters, harvesters, sprayers, irrigation rigs and other equipment, you know all too well the difficulties encountered among the myriad different computer file formats.

Thanks to AgGateway, a non-profit consortium of ag companies, the ADAPT format has been developed to provide an easier way to compile and analyze data from various sources.

ADAPT allows each equipment manufacturer to keep its proprietary software and technology but allows participating companies to export to or import from a common open-source ADAPT file format.

Several major original equipment manufacturers, including AGCO Corp., Ag Leader Technology, CLAAS, CNH Industrial, Deere & Co., Praxidyn, Raven Industries, Topcon Precision Agriculture and Trimble Navigation, have made formal commitments to release ADAPT plug-ins.

UNIVERSITY OF FLORIDA PROVIDES WATER-SAVING TOOL TO SUWANNEE FARMERS

During most of 2016, Suwannee County, Fla., farmer Sammy Starling never had to guess when he needed to water his corn. With new smart-agriculture technology, he could access soil moisture readings right from his phone, with updates every three hours.

Thanks to a University of Florida Institute of Food and Agricultural Sciences Extension trial, Starling was one of three Suwannee River Valley farmers who got the chance to test drive the water-saving technology.

By showing farmers how to use and benefit from these sensors, the trial encouraged producers to adopt best management practices (BMPs) set out by the Florida Department of Agriculture and Consumer Services, says Patrick Troy, regional specialized agent in row crops who has spearheaded the initiative.

Starting in November 2015, Troy began supplying participating farmers with soil moisture sensors and teaching them how to use the devices and interpret data. With these data, farmers could make more informed decisions about when and how much water to apply. Proper timing and rates ultimately save water, Troy says.

On average, the three farmers in the trial saved about 8 percent in water expenditures with the sensors, Troy says. With 142,000 acres of irrigated land in the Suwannee River Valley, wider adoption of this technology could make a big impact on the region, he says.

MSU LAUNCHES ONLINE USER-FRIENDLY GIS TOOL

The Geosystems Research Institute at Mississippi State University has released GeoDawg, a new user-friendly geographic information system, or GIS, Web application.

The online tool allows users to view high-resolution aerial imagery, find elevations anywhere in Mississippi, and create and share maps with others, among other uses. GeoDawg provides a collection of tools to access a list of map layers, search the Internet for comparable GIS servers or create maps on top of base maps.

In the past, GIS programs have been costly and cumbersome, with a steep learning curve. Mississippi State University developed the software to share a large collection of GIS data acquired through grants from the state of Mississippi.

Although the software was designed for ease of use, a downloadable users manual also is available.

Visit https://geoproject.hpc.msstate.edu/geo Dawg to access GeoDawg.