Costs, Benefits, and Limitations of Irrigation Management Technologies

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The irrigation management technology landscape is dynamic. With new developments coming to market every year, it can be challenging for producers to evaluate which tools may be best for their farming operation. The goal of this resource guide is to lay out benefits, limitations, and other important considerations related to four common irrigation management tools:

1. Weather stations and atmometers
2. Irrigation scheduling software tools
3. Soil moisture (soil water) sensors
4. Telemetry: remote irrigation system management

Can irrigation management technology pay for itself?

Producers want to know if their technology investment can/will pay for itself after the initial purchase and ongoing maintenance costs. For example, will the tool:

- Reduce labor and travel for system management?
- Reduce irrigation pumping and system wear?
- Increase yields and/or crop quality?
- Help conserve groundwater?

For some growers, technology may offer invaluable peace of mind that comes from knowing when to irrigate, knowing the system is operating correctly, and complying with water use restrictions or conservation goals.

Irrigation management technology can now be accessed and managed from the palm of a producer's hand. Access to more precise information, as well as remote monitoring and control, can save money and provide producers peace of mind that comes with accurate and reliable irrigation system management. Photo: Colorado State University

Weather Stations and Atmometers

Description

Weather stations and atmometers provide weather information to help estimate evapotranspiration and crop water needs. Evapotranspiration (ET) is plant water loss from the processes of evaporation and transpiration. ET-based estimates of crop water needs are generated by combining local weather data with cropping system information. Local ET data can be accessed from different sources, such as publicly managed weather station systems and private onsite weather monitoring devices, such as atmometers. Some irrigation scheduling tools (see page 3) also use ET data.

Examples of Publicly Funded Weather Station Systems

Colorado Agricultural Meterological Network (CoAgMET); Nebraska Mesonet; Oklahoma Mesonet; New Mexico Climate Center

Example of Atmometer Trade Names

ETgage®

Value to Producer

- Reduce labor
- Reduce travel
- Reduce system wear
- Increase yields
- Conserve water
- Provide peace of mind

Cost to Producer

- Publicly funded weather station data: Free to user
- Commercially funded weather station data: subscription fees vary
- Atmometer/ETgage®: $250 - $1,200
- Edge-of-field weather stations: $500 - $7,500+

Benefits

- Provides an estimate of crop water use to better inform irrigation scheduling
- Public weather station data available free in some regions
- Can be used to help inform other management practices (e.g. chemical spraying)

Limitations

- Data accuracy depends on weather station siting, calibration, and maintenance, as well as proximity to nearest weather station or atmometer
- Requires an understanding of how reference ET data and crop coefficients relate to specific crops
- Requires an understanding of how ET data informs irrigation schedules

Industry Feedback

"Here is an example of how to figure ET. I have an ETgage® in a field located in Valley County, NE. The reading over the past week was 1.8 in. This is a corn field at the V6 growth stage. We refer to the [crop coefficient chart] and find that it is 0.35. We then multiply 1.8 in. by 0.35 and get 0.63 in. Divide this figure by seven days in the week and we have 0.09 in. of water used per day this past week. So as you can see, when the crop is early in its development, it is not using much water each day." *UNL Extension Educator, NE*

More Information

» Colorado Agricultural Meterological Network (CoAgMET) - *coagmet.colostate.edu*
» Nebraska Mesonet - *mesonet.unl.edu*
» Oklahoma Mesonet - *mesonet.org*
» New Mexico Climate Center - *weather.nmsu.edu/ziamet*
» "Using Modified Atmometers for Irrigation Management" (University of Nebraska-Lincoln Extension) *extensionpublications.unl.edu/assets/pdf/g1579.pdf*

Irrigation Scheduling Tools

Description

Irrigation scheduling software tools are computer programs that allow a producer to input their farm's unique parameters and connect to other monitoring indicators such as local weather, evapotranspiration (ET) data, and/or soil moisture probes. Some irrigation schedulers keep track of the daily soil water balance and the need to irrigate by accounting for all water additions (irrigation and rainfall) and water losses (evapotranspiration, deep percolation, and/or runoff). This is also known as the "water balance" or "checkbook method."

Examples of University Tools

KanSched (KSU); DIEM - **D**ashboard for **I**rrigation **E**fficiency **M**anagement (Texas A&M); WISE - **W**ater **I**rrigation **S**cheduler for **E**fficient Application (CSU)

Example Trade Names

AquaPlanner; FieldNET Advisor™; Valley Scheduling™

Value to Producer

- Reduce labor
- Reduce travel
- Reduce system wear
- Increase yields
- Conserve water
- Provide peace of mind

Cost to Producer

- Publicly funded University tools: Free to user
- Private industry tools: $300 - $400 per pivot

Benefits

- Provides an estimate of crop water use to better inform irrigation scheduling
- University tools provide a no-cost opportunity to test how irrigation scheduling tools can support irrigation management
- Some private industry tools are part of comprehensive ag management platforms that may also offer weather, yield, and irrigation forecasting, remote irrigation system management, and/or variable rate irrigation (VRI) prescriptions

Limitations

- Public weather station networks are not available in all areas
- Accurate weather station data for a particular field are impacted by distance to the nearest station and equipment siting, calibration, and maintenance.
- Requires the availability of appropriate crop coefficients (K_c) to accurately represent crop water use for different crop types at different growth stages
- Requires appropriate characterization of soil type
- Requires estimation of irrigation application efficiency

Industry Feedback

"The ET-based irrigation scheduler [WISE] helps me decide how much water my corn crop should be using for the next two or three days, so I can appropriately decide whether I can get by with shutting the sprinkler off or keep it running." *Producer, Yuma, CO*

More Information

» "Irrigation Scheduling Tools" (OWCAP) - *ogallalawater.org/irrigation-scheduling-tools*
» KanSched (Kansas State University) - *kansched3.engg.ksu.edu*
» Dashboard for Irrigation Efficiency Management (Texas A&M) - *diem.tamu.edu*
» Water Irrigation Scheduler for Efficient Application (Colorado State University) - *wise.colostate.edu*

Soil Moisture Sensors

Description

Soil moisture sensors use various indirect methods to estimate soil water levels. Although soil moisture monitoring should not be expected and solely relied upon to provide a high degree of precision and accuracy in all scenarios, moisture sensors can still prove to be a useful tool when combined with feedback from other tools and methods used to assess soil moisture and crop water needs.

Example Trade Names

Irrometer, Acclima**,** Cambell Scientific, AquaCheck, AquaSpy, CropX, Hortau, Delta-T, Sentek, IMKO, John Deere, Spectrum, Stevens, Troxler, Delmhorst, Decagon, and others

Value to Producer

- Reduce labor
- Reduce travel
- Reduce system wear
- Increase yields
- Conserve water
- Provide peace of mind

Cost to Producer

- $40 - $350 per sensor
- $500 - $3,500 per unit to manage data (data logger, hand-held meter, or transducer)
- Telecommunications charges or subscription fees to data access may apply (see telemetry section below)

Benefits

- Estimates of plant available water in the root zone support improved irrigation scheduling
- Recent technology improvements in data processing and data display support user friendliness
- Recent technology improvements in the ability to remotely and spatially (across the field) monitor soil moisture increase convenience and data access
- Ability to integrate soil moisture data with some irrigation scheduling tools and remote management systems

Limitations

- Challenges in correctly selecting, installing, and maintaining sensors can affect quality and accuracy
- Challenges in correctly understanding and integrating soil moisture data for irrigation scheduling can limit the value of the information
- Accuracy can be affected by several factors including temperature, salinity, soil texture, and selecting proper sensor location(s) within the field
- Greater variation across field and soil conditions may require more sensors and greater attention to selecting sensor locations

Industry Feedback

"Having a soil probe in each of our irrigated circles has definitely saved us money. How we manage water on our farm using the probes and residue helps keep nutrients in the root zone, preventing money we've spent on them from leaching or washing away." *Producer, Goodland, KS*

More Information

» "Soil Moisture Monitoring" (OWCAP) *ogallalawater.org/soil-moisture-monitoring*

» "Tips on Selecting a Soil Water Sensor" (Kansas State University) *bookstore.ksre.ksu.edu/pubs/MF3407.pdf*

» "Soil Water Sensors for Irrigation Management" (University of Nebraska - Lincoln) extensionpublications.unl.edu/assets/pdf/ec3002.pdf

» "Irrigation Monitoring with Soil Water Sensors" (Texas A&M Agrilife Extension) agrilifeextension.tamu.edu/library/farming/irrigation-monitoring-with-soil-water-sensors

Telemetry: Remote Irrigation System Management

Description

Telemetry products communicate between irrigation hardware in the field and software on a producer's computer, tablet, or phone. Telemetry provides a range of remote capabilities that includes irrigation system monitoring and control of center pivots, end guns, drip systems, pumps, flow meters, soil moisture monitors, weather sensors, tank monitors, and electric motors.

Example Trade Names

AgSense, FieldNet, Valley, and others

Value to Producer

- Reduce labor
- Reduce travel
- Reduce system wear
- Increase yields
- Conserve water
- Provide peace of mind

Cost to Producer

- Initial installation: $300 - $2,300 per unit
- Annual subscription: $100 - $300 per unit

Benefits

- Ability to remotely monitor center pivot system operation - whether it is running correctly or has unexpectedly shut down
- Ability to remotely start and stop pivots in case of rain or pivot malfunction
- Saves travel time and costs to check and operate irrigation system components
- Ability to more precisely apply water, chemicals, and fertilizer and implement variable rate irrigation (VRI) prescriptions
- Some tools can be integrated as part of larger ag management platforms that may offer soil moisture monitoring, evapotranspiration (ET) data, and irrigation scheduling recommendations

Limitations

- Some products require access to cell phone service or other communication means.

Industry Feedback

"One of the primary benefits is the time saved. To physically visit the pivot point and well of every machine we own, we have to travel 143 miles. We still need to do that sometimes, but [remote irrigation] has allowed us to utilize our time much better. When a pivot is stuck or broken, we know about it immediately and we can prioritize our work." *Producer, Sutherland, NE*

"Telemetry provides the opportunity to act in real time to changing conditions. We can save resources and cut costs if we learn to use this technology well." *Producer, Wray, CO*

More Information

» Rudnick, D., Chávez, J., Aguilar, J., Irmak, S., Bordovsky, J., & Burr, C. (2017). Advances in Irrigation. *Colorado Water, 34*(6), 29-32.

Technology Cost Recovery Examples

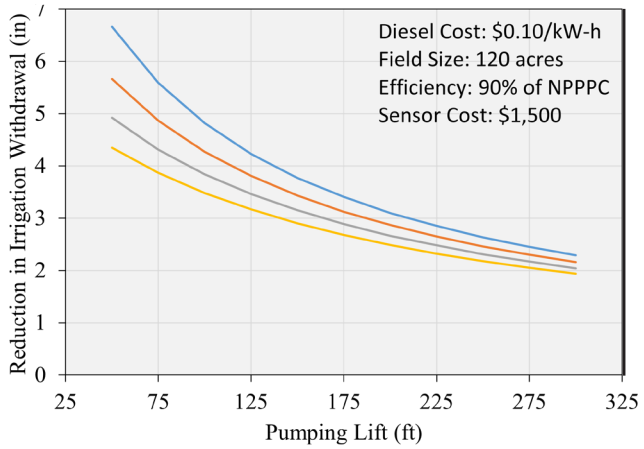

Figure 1. Irrigation systems with higher operating costs (greater pumping lift and/or higher pressure) require smaller pumping reductions to recover costs of using new technology. These data show how a $1,500 technology cost relates to cost savings of inches of water not pumped.

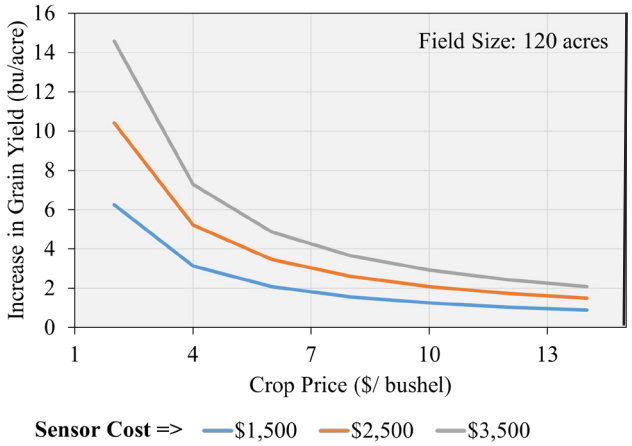

Figure 2. Example of technology cost recovery (Ex: $1,500, $2,500, and $3,500) through increases in grain yield. Higher crop prices can recover these technology costs with 1-2 bushels/acre yield increase. Low crop prices require greater grain yield increases between 6-15 bushels/acre to recover these example technology costs.

Conclusion

The degree to which irrigation technology can benefit an operation will depend upon its ability to reduce expenses (Figure 1), increase revenue (Figure 2), and/or produce other value that justifies the cost of the technology. Starting small and expanding acres with experience and success can be a good strategy to successfully implement a new irrigation technology.

Acknowledgement

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2016-68007-25066, "Sustaining agriculture through adaptive management to preserve the Ogallala aquifer under a changing climate." Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

Ogallala Water Coordinated Agriculture Project (OWCAP)

Citation: Rudnick, D., Porter, D., Aguilar, J., Schneekloth, J., & Warren, J. (2020). *Ogallala water coordinated agriculture project resource guide series: Cost, Benefits, and Limitations of Irrigation Management Technologies* (OWCAP-2020-RGS-Irrigation Management Technologies). Retrieved from http://ogallalawater.org/irrigation-management-technologies/

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United States Department of Agriculture

National Institute of Food and Agriculture

Publication Number:
OWCAP-2020-RGS-Irrigation Management Technologies
(January 2021)