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VOL. 2, ISSUE 4 | April 2018

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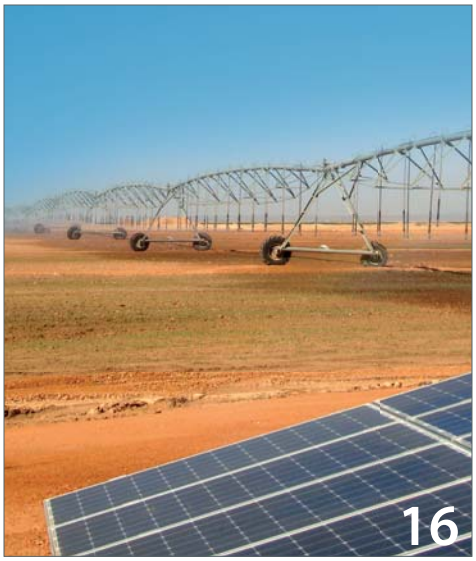

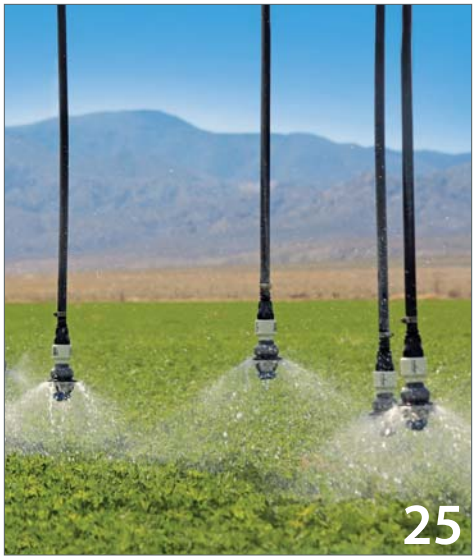

FEATURES

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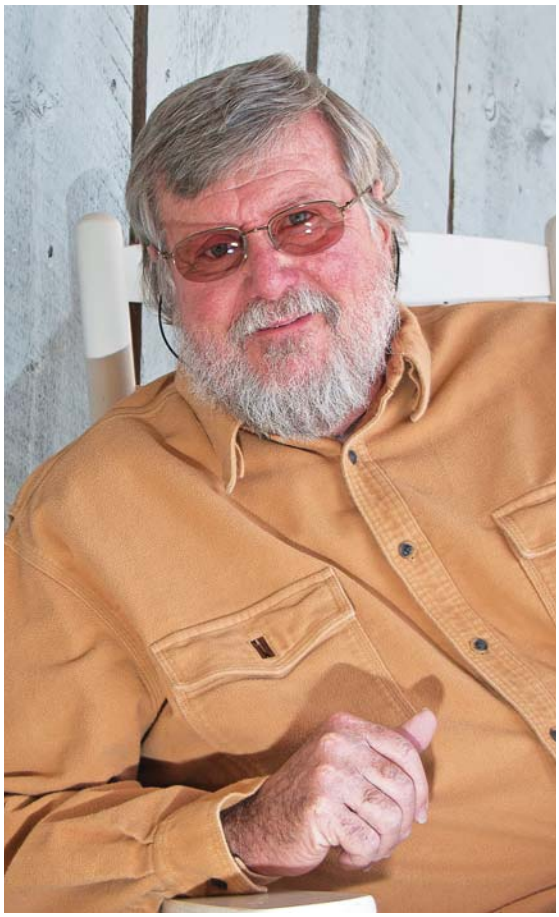

By Stephen W. Smith, PhD, FASIC, CAIS, CLIA
Irrigation Today Editorial Board Chair

Keeping focus on ag's positive future

As I write this editorial for *Irrigation Today*, the shift to daylight saving time and the pending spring equinox are on the short-term horizon. Spring is upon us and highly anticipated in 2018! The news in some agriculture spaces is good, while not so good in others. Concerns abound with snowpack reports in the western United States, predicted water shortages and the recurrence of drought conditions in multiple locations.

But on a very positive note, I have just participated in an incredible brainstorming session with researchers, mostly agricultural and irrigation engineers, from five of the land-grant universities.

The enthusiasm was contagious with affirmation of existing and new technologies that will be important to irrigated agriculture.

High-level goals of our researchers include: increased food production, increased water-use efficiency, verification of economic suitability of certain new technologies, instrumented irrigation control systems, and detailing of the basic need for actionable data in irrigated agriculture. Of particular related interest in this issue is the article by Drs. Yoshi Osroosh and Diganta Adhikari about the "internet of things" on pg. 6-7.

Recently, the Irrigation Association organized visits to Capitol Hill to meet with our legislators and promote recommended changes in the 2018 U.S. Farm Bill. The IA's efforts are more focused than ever before to achieve targeted goals. Those efforts are much appreciated. As you consider further irrigation upgrades, consider how the Natural Resources Conservation Service's Environmental Quality Incentives Program might help with cost sharing of suitable practices.

As we progress into 2018, let us know what you think of recent articles and content in *Irrigation Today*. We want to provide information that is useful to you. Your feedback is important. Email your comments and suggestions to me at **swsmith@buenavidafarm.com** or to Editor-in-Chief Anne Blankenbiller at **anneblankenbiller@irrigation.org**.

Here's to the 2018 cropping year!

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Using the power of IoT to improve irrigation water management

By Yossi Osroosh, PhD, and Diganta Adhikari, PhD

Efficient management and optimization of farm inputs will be key to feeding the growing world population. However, managing these inputs, such as irrigation schedules, will require real-time data from networks of soil, crop and weather sensors at a desired resolution and reasonable cost.

Wireless sensor networks could conveniently collect soil and crop data in granular detail from various parts of the agricultural field to capture the spatial and temporal variability that exists in the field. Similarly, wireless actuators could also be used to turn irrigation valves on/off remotely based on real-time information from the in-field sensor network. For example, when soil moisture sensors and near-infrared sensors detect a preset threshold value, the in-field sensor network could either send an alert to the grower to initiate or stop an irrigation event or, alternatively, send the data wirelessly to an actuator to turn irrigation on/off autonomously.

Existing or emerging sensors and actuators could be made wireless with the aid of a wireless communication device. This need has led to the development of low-power wide-area networking, or LPWAN, within the "internet of things" technology network. LPWAN technologies are intended to connect low-cost, low-power sensors to cloud-based services. Today, there are a wide range of wireless and IoT connectivity solutions available, raising the question of which LPWAN technology best suits the application.

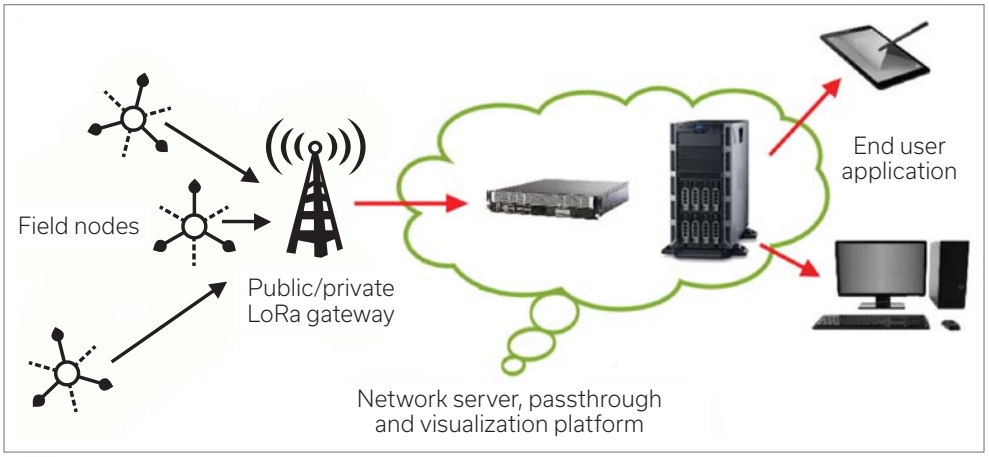
Here are the scenarios for implementing IoT: 1) buy a sensor that will connect to a wireless network that you own (i.e., customer supplied like Wi-Fi, Bluetooth), 2) buy the infrastructure (or at least pieces of it) to install on-site (i.e., vendor-managed LPWAN such as LoRaWAN or Symphony Link), or 3) rely on the infrastructure from a LPWAN network operator (e.g., LTE Cat-M1, NB-IoT, Sigfox, LoRaWAN).

LPWAN technology fits well into agricultural settings where sensors need to send small bits of data over a wide area while relying on the battery to last multiple years. The low-power and range features distinguish LPWAN from Bluetooth, ZigBee or traditional cellular networks with limited range and higher power requirements. However, like any emerging technology, certain limitations still exist with LPWAN. For example, in real agricultural settings, field tests have shown LoRaWAN gateways (or the data communication device) to have a range of up to 4.5 miles over a corn canopy, but that only occurred when gateways were placed 33 feet above the ground. With gateways placed at 10-12 feet above ground, the range was found to be about 0.5 miles.

Managing farm inputs will require real-time data at a desired resolution and reasonable cost.

A one-to-many approach to architecture is common with respect to wireless communication. Existing wireless technologies like Bluetooth LE, Wi-Fi or ZigBee can be used to collect in-field data. In this case, data could be transmitted in and out of the field through existing communication infrastructure like a traditional cellular network (e.g., 3G, 4G) or LAN. Alternatively, private or public LPWAN solutions such as LoRaWAN gateways or cellular IoT can be used to push data to the cloud. For example, a grower can have a network of soil moisture sensors in the field equipped with radios. These sensors wirelessly report their measurements back to a datalogger installed in a corner of the field at no cost. The datalogger can use a SIM card and regular mobile data plan to send data to a remote computer.

Most LPWAN technologies (e.g., Sigfox and NB-IoT) currently have a very limited network coverage in the United States. For example, we tested a LoRa device for



Example: Data flow through public/private gateway infrastructure

connectivity at various locations within the Central Valley of California where some infrastructure of connectivity has already been established by a private company with a subscription fee-based system. We were able to confirm connectivity in 17 of the 26 locations.

LTE Cat-M1 by far has the largest coverage and the fastest data rate. Sensor data usage is the most important driver of the cost in using cellular IoT, as rates are tiered based on data usage. According to the Business Insider website, it is anticipated that by 2020, IoT-based devices will generate 500,000 data points per agricultural field per day, which should help the IoT market mature and lower costs significantly. Cellular IoT like Cat-M1 works best for ag applications where sensors are required to send data more frequently and where controls like actuating valves or turning pumps on/off are involved. As the Cat-M1 network expands, it will likely have better coverage in the urban areas first compared to rural areas where agriculture tends to be more pervasive.

Cost estimations and network coverage (prices as of February 2018)

Technology	Connectivity cost {/month/device}	Infrastructure cost	Network coverage
LTE Cat-M1	$1.00-$2.00		High
NB-IoT	~$1.00 for 100kb		Low
Sigfox	<$1.00		Low
LoRaWAN public	$1.00-$2.00		Low
LoRaWAN private	$0.25	$500-$1,500	
Symphony Link	$0.25	$500-$1,500	

With the rapid growth of IoT in other areas, there will be an opportunity to evaluate different IoT technologies before adapting them for agriculture. As a company, you may be forced to choose specific IoT technology; however, growers and consultants should not worry about what solution is employed to transfer data from their field to the cloud and to their computer or smart phones, as long as quality data is collected and securely delivered efficiently at a reasonable cost.

***Yossi Osroosh, PhD**, is affiliated with the Washington State University Prosser Irrigated Agriculture Research and Extension Center and is currently contracted as a research scientist with METER Group Inc. His research is focused on imagery-based crop sensing and management, agricultural IoT and precision irrigation.*

***Diganta (Dig) Adhikari, PhD**, is the director of engineering for Irrometer Company Inc. He has over 16 years experience in water management, environmental engineering, consulting and project management, focused both on government and industry clients.*

Agriculture, infrastructure & budget

Congress sets its schedule through spring.

By John Farner, Irrigation Association Government and Public Affairs Director

As Congress hits its stride in this election year, many issues relating to irrigated agriculture and water policy remain on the table.

Farm bill

First and foremost is the farm bill. Yes, it's a farm bill year. Every five years Congress develops a comprehensive agricultural policy in the form of a farm bill that addresses everything from research, to subsidies, to crop insurance, to the Supplemental Nutrition Assistance Program, to conservation, and everything in between. Even though it is not a regulatory bill, the farm bill can be controversial its own right, but because of its necessity and importance to U.S. agriculture, it has eventually passed Congress in a somewhat timely fashion each time it was up for reauthorization.

A strong focus of the irrigation industry is the Environmental Quality Incentives Program. Part of the conservation title of the farm bill, EQIP is a national program administered by the Natural Resources Conservation Service that provides financial assistance to farmers who seek to increase their practices and/or technologies to be more environmentally friendly. EQIP is now the go-to program for farmers to use for cost-sharing irrigation efficiency improvements. While this program is successful, limitations remain that hinder many growers from fully taking advantage of the program.

The draft of the House of Representatives' farm bill takes strong steps in enhancing the EQIP program. First, through the life of the draft farm bill, EQIP will increase in mandatory spending to $3 billion. Second, it expands the Regional Conservation Partnership Program to not only expand beyond critical conservation areas,

but it also allows irrigation districts to be eligible for funds. Finally, it eliminates the Conservation Stewardship Program. The irrigation industry welcomes these changes, but the future focus should be on a balance between productivity and conservation.

The current farm bill expires on Sept. 30, 2018. While we remain cautiously optimistic that a farm bill passes Congress and will be signed into law by this deadline, this is not a time for apathy. It's time for irrigation's voice to be heard. For more information how to be involved, please visit **www.irrigation.org/farmbill** or **www.waccoalition.org**.

It's time for **irrigation's voice** to be heard.

Infrastructure

In February, the Trump administration released an outline for the much-anticipated infrastructure package. With a proposal now out, it's up to Congress to figure out how to not only fund the package but also decide where to prioritize the projects.

With a significant portion of our nation's water moving through agricultural irrigation technologies, our industry is heavily dependent on a 21st century water infrastructure. Farmers depend on reliable sources of water to meet the demands of a growing population. Therefore, water infrastructure is of critical importance to the irrigation industry. In many cases, today's infrastructure is insufficient to meet the growing demands of our society, as much of the infrastructure was designed to accommodate a smaller population, lower economic activity and lower environmental regulations than we experience today and expect to see in the future.

The blueprint the White House released in February eliminates the Environmental Protection Agency's authority to veto the Army Corps of Engineers' wetlands permits in addition to proposing a two-year limit for agencies to issue final permitting decisions, including a strict 21-month limit on analyses done under the National Environmental Policy Act of 1970.

It remains to be seen how Congress will consider Trump's proposal, or if they will take up a comprehensive infrastructure package at all. With a price tag of $200 billion over 10 years and a significant reduction of environmental and regulatory protections, both Republicans and Democrats have expressed concerns of the plan as proposed.

Budget

President Trump's fiscal year 2019 budget is out and calls for steep cuts to domestic programs, including many in the EPA, Department of Energy and USDA. Though the cuts don't touch programs like EQIP, due to fact that EQIP funding is set at mandatory levels by the farm bill, other programs in research and nutrition face steep cuts in the Trump proposal.

Congress is set to debate the FY2019 appropriations level through this summer. With a deadline of Sept. 30 and a budget already passed, many on Capitol Hill are hoping to fund the government through the normal appropriations process, rather than an omnibus package and/or continuing resolutions, as we've seen in years past.

Where am I on the PUMP CURVE?

— By Len Ring, MSc, PE, CID —

Pumping station using VFD-controlled pump motors in the Western Irrigation District, Alberta, Canada

SPEED, EFFICIENCY & ENERGY CONSUMPTION

Pumps often provide the flow (gallons per minute) and pressure (pounds per square inch) or head (feet) to match an irrigation system design. If selected well, they provide that flow and head efficiently. If one pump is used, one pump curve will indicate the flow and head that can be expected. With multiple pumps, a combination pump curve can be developed for the pumps in parallel or series as necessary. When referring to a pump curve in this article, it is referring to the single pump or combination pump curve, whichever applies. The pump curves shown (pg. 12) are derived from an actual manufacturer's pump curves, revised using the affinity laws.

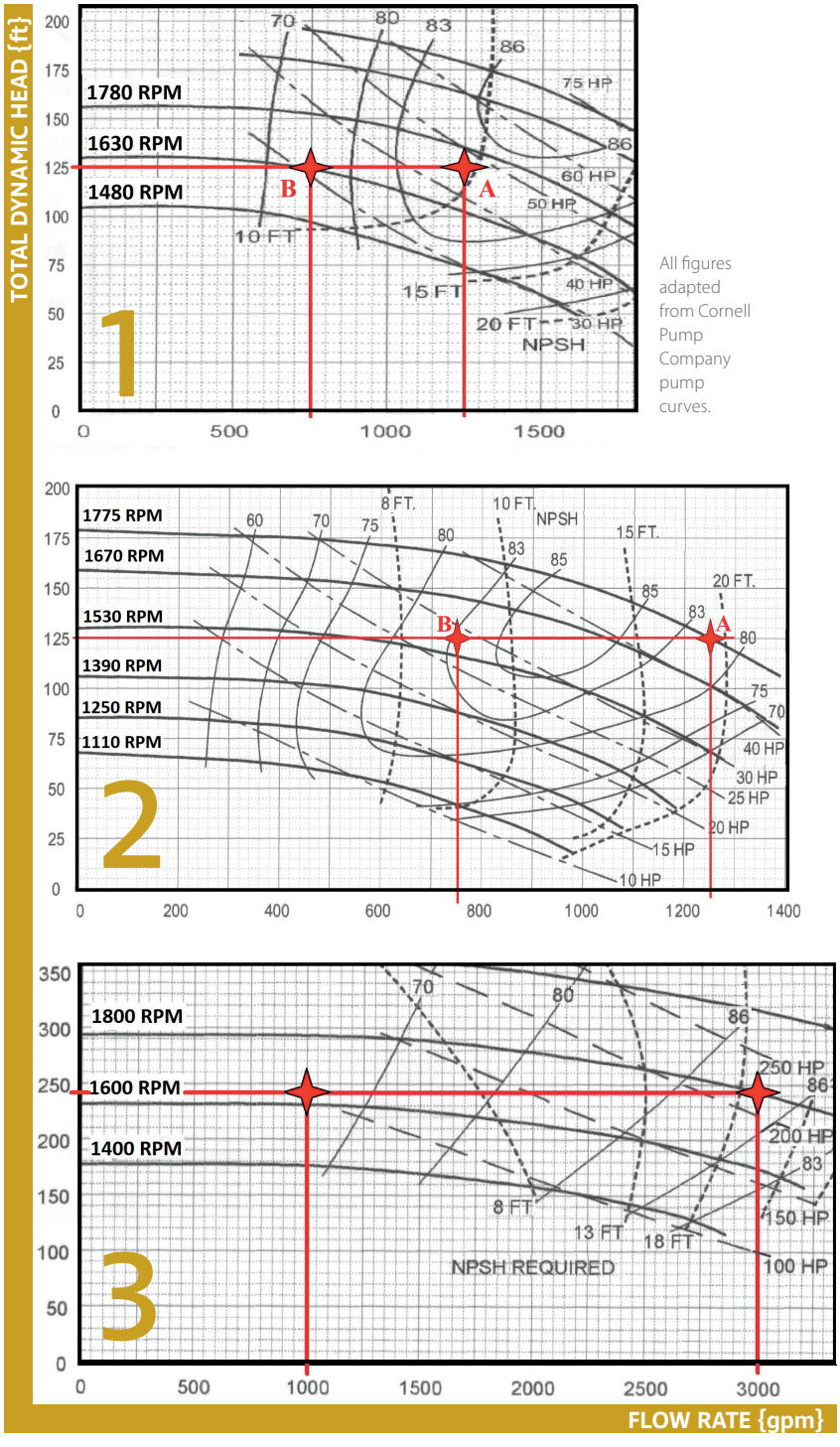
System curves & pump curves

System curves show how an irrigation system flow increases as the input pressure increases. Pump curves show how the head developed decreases as the flow increases. The pump and system operate at the point where the two curves cross. This is a key concept in order to know where we are on the pump curve.

If the irrigation system is simple, an efficient pump can easily be selected.

If the irrigation system is simple (e.g., one center pivot, no end gun, no corner arm and flat topography) there is one system curve, and an efficient pump can easily be selected. With a complicated system (e.g., multiple center pivots with corner arms, a golf course with various sized zones, an irrigation district system serving many parcels, etc.) there are many system curves with a wide variety of flows, and choosing a pumping system that always works efficiently is more difficult.

Pump curves



All figures adapted from Cornell Pump Company pump curves.

Pumping station using pressure control valves in the Raymond Irrigation District, Alberta, Canada (pictured: Len Ring)

Designing for varying flows – VFDs

In recent years, variable frequency drives have become a popular choice for pumping systems with varying flows. They can replace pressure-reducing valves used to control discharge pressures. This makes the design process easier. A VFD may be used to reduce energy costs, but the owner may find that energy savings were not as large as expected. The other benefits of a VFD (i.e., smoother operation, better pressure control, less hydraulic transients/water hammer, less maintenance) may make up for the less than expected reduced energy.

Why didn't I save more energy?

Because VFDs make designing easier, a designer may pick pumps that can provide the maximum pressure and flow and then let the VFD look after the other operating points. To reduce capital cost, the designer may use the fewest number of pumps, each operating over a wide flow range. With a VFD the pump will still operate on its pump curve, and that point must be known in order to predict the energy consumption. It is important to also take into account the VFD's efficiency. Typically, they are 95-97 percent, so a savings of 3-5 percent in energy is necessary — just to break even.

Which pump to choose?

An operator wants a pump that will produce 750-1,250 gpm at a pressure of 54 psi (125 feet total dynamic head). Using pump curves 1 and 2 provided (left), the operator would initially pick pump 1 over pump 2, as the efficiency at 1,250 gpm is better (84 percent to 82 percent), but this would not be the best choice.

As the flows drop, pump 1's efficiency drops from 84 percent to 75 percent at 750 gpm. Pump 2's efficiency is 82 percent at 1,250 gpm, but it increases to over 85

percent from 850 to 1,100 gpm and is 83 percent at 750 gpm. Pump 2 would be a much better choice.

How many pumps to choose?

An operator may pick one pump for his entire system and let the VFD control it over a wide variety of flows. If you have a system with widely varying flows but want to keep the pressure constant, you would look for a flat pump curve like pump 3. If pump 3 was selected for flows from 1,000 to 3,000 gpm (240 feet TDH), it could accomplish that outcome, and the speed would only vary from 1,800 to 1,630 rpm. At 3,000 gpm, the pump efficiency is good (>86 percent), but at 1,000 gpm it is well below 70 percent. We can't even estimate it. If the system operates at lower flows a majority of the time, this would not be a good choice from an energy savings standpoint. Two pumps in parallel that operate efficiently from 1,000 to 1,500 gpm would be better. If energy use is not an issue, the operator may still choose a one-pump system for its simplicity, but two pumps would be more efficient and part of the system could still be operated if one pump is down for repairs.

In conclusion, don't use VFDs as an easy way out when designing your pumping system. Understand where you are on each pump curve for all of the possible flow scenarios. If predicting energy use is a priority, obtain accurate data regarding how often the system operates at various flows.

***Len Ring, MSc, PE, CID**, is an agricultural engineer who has been involved with irrigation in western Canada for over 40 years. He currently operates Ring Irrigation Engineering, specializing in the design of on-farm irrigation systems, pipelines and pumping stations. Ring was the author of Chapter 8 "Irrigation Pumping Plants" in the Irrigation, Sixth Edition textbook.*

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Smart Irrigation Month is an initiative of the Irrigation Association, a nonprofit industry organization dedicated to promoting efficient irrigation.

Is it time to reconsider solar power irrigation in your operation?

By Eric Macias

There is a natural synergy between the amount the sun shines and the amount of water that we need to achieve the highest crop yields. Taking this thinking forward, it is easy to see how solar power could be a logical energy source for our energy-hungry irrigation pumps.

The world is changing

Using solar pumps for stock water applications has become ubiquitous; this application was really the first for solar pumping. Replacing windmills with solar pumps makes sense — no maintenance and low power requirements because of modest flow and storage of water in a trough. Most stock water applications use pumps in the 1-3 horsepower range.

When considering irrigation applications, the pumping requirements get much bigger, quickly moving to 10, 20 and 50 horsepower (and bigger) pumps. Historically, using solar power for these types of applications was either technically not possible or cost prohibitive. However, today the technology, market and political agenda have moved forward:

- Prices of photovoltaic modules have reduced by 10 times, making large solar pumps affordable.
- Motor efficiency improvements have further reduced the power needs, which also improves the economics.
- Massive advances in microprocessor-driven controllers and software, specifically designed for solar water pumping, provide further efficiency and intelligent drives.
- Energy and fossil fuels are getting more expensive and, in many places, are becoming less reliable or are subject to forms of technical or economic rationing.
- There is a high level of interest in renewable energy, sustainability and responsible energy use.

Photo above: This 300-acre orchard in Croatia includes a "pond" built to store water that is fed by solar pumps. The solar pumps are also used to pressurize the water to a drip system for apples and peaches.
Photo credit: BERNT LORENTZ GmbH & Co. KG

What about solar power for irrigation & specifically solar water pumps?

Across many parts of Africa, the Middle East and Asia, solar power for irrigation has become the norm. In these markets, diesel was the only choice for power but has now been replaced by solar. Large-scale flood irrigation with single systems pumping 1 million gallons per day are now not uncommon. Across North Africa, whole areas are being changed from deserts to productive fields by using full-size center pivots and solar pumps. Both the pivot and pumps are powered from the sun.

Modern solar pumping systems are smart, smaller systems using high-efficiency motors (direct current brushless) to allow them to operate effectively as the available energy from the sun changes. Remote monitoring and management are features of the best-of-breed systems offering the capability of managing a remote plot from afar.

The larger systems all have variable speed drives included, and there are even hybrid systems that will blend together solar and power from a generator to give backup power when the sunlight is not sufficient to achieve the desired flow, pressure or level. This allows for constant pressure, level or flow to be achieved using hybrid solar-powered pumping systems.

Holistic irrigation solutions

The best solar irrigation solutions look at the crop's requirements, soil type and water availability and then find the irrigation method that fits best. Changing an existing irrigation pump to solar might not give satisfactory results unless all factors have been taken into consideration.

Best results come from changing irrigation methods and habits to better meet the daytime pumping requirement. An example of this is using subsurface drip irrigation for fruits, trees and nuts. By using subsurface irrigation during the daytime, losses due to evaporation are minimized. Studies carried out in the Middle East show that production can be increased by reducing watering levels using subsurface precision irrigation.

Does solar always make sense for irrigation?

If you are paying $0.08 per kilowatt-hour for electricity, have a short irrigation season and require 24-hour pumping, then solar-powered irrigation would typically be financially unattractive. But, there are many scenarios where solar irrigation becomes interesting:

- You have a plot where there is no power, and the electric company wants $50,000+ to connect power.
- In areas where you are running a generator for pumps — with all the trouble and cost of refueling and servicing — solar will be cheaper and much easier.
- There are scenarios where "growing green" can add value to your product. Think about the next step beyond organic where you have carbon neutral production.
- Investing in solar can provide interesting financial returns.
- If the existing power grid has reliability or quality issues that continuously shorten the life of pumping equipment, it can jeopardize the availability of the water supply.

***Eric Macias** is the chief operating officer for LORENTZ US Corp. During his career, he has worked in the irrigation industry in customer service, sales, training and marketing, until discovering his passion for pumping water using renewable energy.*

What is a solar water pumping system?

A typical solar water pumping system has three components:

solar generator – This includes one or more photovoltaic modules that convert photons (light from the sun) to electricity. These modules will produce electricity whenever there is light. The brighter the light source the more electricity is generated. The PV modules have a long life, are robust and typically have a warranty of 25 years.

pump controller – The controller monitors the system; provides inputs for sensors such as run dry, pressure or level measurement; and performs voltage and frequency conversions (like a variable frequency drive) to match the available power from the PV modules.

electric pump – Motors optimized for solar are variable speed, may have different windings for specific "solar friendly" voltage ranges and are high efficiency. Permanent magnet motors (electronically commutated direct current) are often used because of their superior efficiency.

This center pivot in Sudan utilizes solar-powered pumps and pivot in a field growing alfalfa for livestock and crops eight to nine times per year.
Photo credit: BERNT LORENTZ GmbH & Co. KG

We're **civilized people** out here.

Managing groundwater together in western Kansas

By Stephen Lauer and Matthew Sanderson, PhD

Adapted from the November/December 2017 issue of *Colorado Water*

Our goal as sociologists on the collaborative U.S. Department of Agriculture National Institute of Food and Agriculture-funded Ogallala Coordinated Agriculture Project is to identify ways of managing groundwater that are most useful and meaningful to the people living in the High Plains region. Through in-person interviews and a survey, we are trying to better understand the values and motivations that influence producers' groundwater management decisions.

Some of our preliminary results suggest that producers from western Kansas draw on a range of values to make decisions about groundwater, weighted toward economic considerations. Producers are very concerned about the costs of inputs and commodity prices, for example, when they talk about water.

From there, conversations can quickly turn to broader and deeper issues, often leading producers to ask: What would it mean to be unable to pass on a viable operation to the next generation because of wells becoming unproductive? What is really being saved when water is conserved? What should the role be of producers in society? To whom, or what, are we responsible for as producers? What is the real value of water?

Producers experience conflicting values, succinctly summarized by one producer as "a tension between rugged individualism and some sort of a community social contract." How do producers act on these core values to manage their water resources in a depleting aquifer? One area that shows great promise is the recent development of voluntary efforts of producers in Kansas' Sheridan and Wichita counties that combine technological and policy tools to conserve water.

Several years ago, producers near Hoxie in Sheridan County, Kansas, approached the constraints of a declining aquifer as an opening for community conversations. A series of formal, four-hour-long and sometimes contentious meetings about groundwater management were held, using an "everybody speaks" format. Meanwhile, informal conversations took place among two or three producers at a time as they ran into each other or sought each other out to pitch ideas and reflect on the previous formal meeting.

Producers are very concerned about the **costs of inputs** and **commodity prices**, for example, when they talk about water.

Photo credit: Richard Rockel

Kansas Governor Sam Brownback speaking at a Wichita County Water Conservation Area informational meeting. The WCA tool, approved in 2015, allows local landowners to develop their own plans on how they would like to conserve water to extend the lifetime of their local water supplies and gain additional flexibilities for their water use over time. The Wichita County WCA was created by county landowners and stakeholders to address the continued decline of the Ogallala Aquifer in their area.

The give-and-take of formal and informal conversations generated an iterative process of deliberation and negotiation through which producers recognized that there is a shared problem with groundwater. The outcome was a plan to conserve groundwater through the Sheridan 6 Local Enhanced Management Area.

Area producers describe a **change in mindset** toward greater enthusiasm for voluntary groundwater conservation.

A LEMA is a Kansas legal tool under which producers voluntarily draw up a contract with rules on water use. Upon approval by the local Groundwater Management District and the chief engineer, this contract becomes binding on all producers in the geographic area.

Established in 2013, the locally developed Sheridan 6 LEMA is broadly supported, as it respects the values of upholding the "community social contract" and "rugged individualism." So far, participating producers tend to believe that they have become better groundwater managers. One producer remarked, for example, that "you don't see irrigation pivots running after a rainstorm anymore."

Area producers are also encouraged by recent findings from the Kansas Geological Survey, which show that the Ogallala Aquifer in their LEMA is declining much more slowly, and perhaps even rising slightly, compared to adjacent areas.

Area producers describe a change in mindset toward greater enthusiasm for voluntary groundwater conservation. According to one producer, "I think about [water] all the time. In many ways, we're 15 to 20 years too late. But I think about it like an NFL quarterback. No, you don't forget about the last play, but you always move forward and focus on what you can do now ... we're all doing our part to keep our families and traditions afloat, maintain what we have and pass it on."

Meanwhile, similar efforts are emerging in other areas over the aquifer.

In Wichita County, Kansas, the Ogallala Aquifer is 65 percent depleted and recharges extremely slowly. At current use rates, the aquifer will not be viable for irrigation in 20 years, but some farms are already unable to pump enough groundwater to irrigate.

We heard stories of families that have abandoned the homesteads that their great-great-grandparents built because the domestic wells ran dry, and it was

too expensive to pipe in drinking water. While most homes still have access to drinking water, folks in the area expect these experiences to become much more common over the next 50 years.

Faced with this reality, producers in Wichita County are taking voluntary group actions to create a different future. Their effort began with a team of 11 producers and local leaders meeting in the basement of an area cattle feeder. They hired a pastor to facilitate a year of conversations — many of which were described as "difficult" — about sustaining water to preserve their economy, their community and their way of life.

Their effort bore fruit this year in a county-wide Water Conservation Area, which provides water management flexibilities to water right owners who work to conserve and extend their water supply.

> "What was never thought possible is now within our grasp: **sustainable use** of the Ogallala Aquifer is attainable."

With widespread participation, the Wichita County WCA is expected to extend the irrigation horizon to 50 years. The hope is that technological advances during this time will make dryland agriculture sufficiently productive to sustain Wichita County communities after irrigation is no longer possible.

Matt Long, a co-organizer and participant in the Wichita County WCA, describes significant early progress toward this goal. "We are only a few months in," Long says, "but already our WCA, through voluntary participation, has committed to saving enough water to support 22,000 people for one year."

In Hoxie on July 18, 2017, Kansas Governor Sam Brownback and state representatives met with local water leaders who have been instrumental in developing the Sheridan 6 LEMA and the Wichita County WCA. Governor Brownback congratulated producers for their successes.

"The data reveals that the voluntary efforts happening as a part of the 50-year Water Vision are being rewarded," said Governor Brownback. "The Ogallala is replenishing itself faster than we previously knew. What was never thought possible is now within our grasp: sustainable use of the Ogallala Aquifer is attainable."

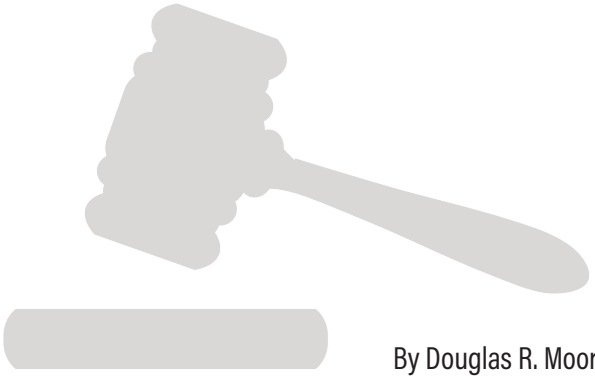
"It's all about leadership," says Scott Foote, owner of Hoxie Feedyard, who hosted the event. "It's doing the right thing and working with your neighbors, and now look what we accomplished together."

__Stephen Lauer__ has earned a master's in community and regional planning from Iowa State University and is currently a graduate student at Kansas State University working toward a PhD in sociology.

__Matthew Sanderson, PhD__, is an associate professor of sociology at Kansas State University. He is a social scientist specializing in the social aspects of natural resource use and conservation.

For more information, see __www.ogallalawater.org__.

How **legal** & **safe** are you?



By Douglas R. Moore

According to the FAA, legally using a drone requires more than flying it.

With the rise in popularity of drone use, you have likely read numerous articles on the uses of unmanned aerial systems in the agriculture and irrigation industries. As a result, you may be realizing that using a drone is right for your operation. So, what's next? With the high degree of autonomy of the current drones available on the market, it would seem that all one has to do is obtain a commercial quality drone for about $1,000 and head to the field. However, it is not that simple.

The unmanned aerial systems we are experiencing are rapidly evolving. Equipment grows in capability and sophistication, along with numerous apps to meet every need. The Federal Aviation Administration regulations are also evolving. On Aug. 29, 2016, the FAA released its initial rules governing the commercial use of unmanned aerial systems. Part 107 of the Federal Aviation Administration regulations provides the guidelines we must follow.

To use a drone in your operation, you must adhere to FAA requirements for commercial operation of drones. These requirements include registering your drone with the FAA, obtaining a remote pilot certificate, and following the operational requirements of Part 107. After reading the requirements, you may think they don't apply to you because you are not a commercial drone operator and you are not charging anyone directly for the use of your drone. The FAA clearly defines commercial use as any use that is not specifically a hobby or for personal recreation; all other uses are considered commercial. That's a broad definition. Even though you consider your drone activities to be ancillary to your operation, you must have a Small Unmanned Aerial Vehicle Remote Pilot license to legally operate. If a grower uses a drone to evaluate the condition of crops, the FAA considers that a commercial use.

Steps to become a legal UAS pilot

The FAA's website (**www.faa.gov**) is a valuable resource with an entire section dedicated to all the information and knowledge needed to become a remote pilot. If you are a licensed pilot with a current flight review, the basic steps are relatively easy. First, take the FAA Safety Team online course. Upon successful completion, you will obtain a certificate. Next, apply for the remote pilot certificate through the FAA's Integrated Airman Certification and Rating Application online. Finally, meet with a certified flight instructor, airman certification representative, flight standards district staff or designated pilot examiner to obtain your endorsement.

If you are not a licensed pilot or are a licensed pilot with a lapsed flight review, the process is a bit more involved. First, prepare to take the Part 107 test by studying the required aeronautical knowledge. The FAA website has study materials available at no charge. A further check of the web shows commercial online study materials starting at $20, online courses for less than $350 and even formal classroom activities reaching $1,500. Classroom training usually includes hands-on experience with actual drone operation.

Next, register for an account with the FAA's electronic application system — Integrated Airman Certification and Rating Application. Once you have obtained the knowledge necessary to pass the test, locate a center to take the FAA remote pilot knowledge test using the complete testing center list online. Take and pass the FAA Unmanned Aircraft General — Small

Knowledge Test to obtain a knowledge test report. You must achieve at least a passing score (70 percent) on the knowledge test, which consists of 60 questions. Finally, apply for the remote pilot certificate through IACRA online or in writing using the paper application. Applying online significantly shortens processing time and provides a temporary certificate.

Once you have completed basic training and have obtained your remote pilot certificate, you may wish to continue training with courses designed to address areas of specific interest. A course focused on mapping and modeling will provide useful tools for agricultural and water monitoring. Courses are also available that will give you a better understanding of your specific model drone.

Insuring your investment

Basic commercial drones start at about $1,000 and usually come with a high-quality RGB camera. Additional equipment may be added to provide high levels of sensing such as the red edge spectral band, normalized difference vegetation index layer and digital surface modeling. Before long, you can have a considerable investment in hardware. Inadvertent contact with obstructions, drone malfunction and operator error are issues that may cause you to consider drone insurance. Insurance costs vary widely depending on the application. Are you simply using an RGB camera for photography, or have you added various pieces of sensing equipment to do crop evaluation? Annual premiums can vary from $750 to well over $5,000 depending on onboard equipment, area of flight and experience of the operator.

Another option is purchasing insurance via a smart phone app by the hour. This approach allows you to purchase only what you need for a defined period. For example, $1,000,000 coverage for a quarter mile for one hour can cost as little as $10.

Today's drones are capable of autonomous operation, but you — as a commercial remote pilot — must be in control of your drone to operate legally and safely. The FAA's main consideration is safety. Once you are equipped with the knowledge, you will be able to fully conduct legal and safe operation of your drone.

Douglas R. Moore *has nearly 50 years of experience working in the irrigation industry in both distribution and manufacturing. He has been a commercial-rated pilot for 44 years, recently adding a remote pilot certificate.*

Stay on the cutting edge of UAS technology

As drone technology and use continues to change and expand, stay informed by joining a drone industry association. Look online for organizations focused on professional drone operation.

- Association for Unmanned Vehicle Systems International (**www.auvsi.org**)
- UAV Systems Association (**www.uavsa.org**)
- Aircraft Owners and Pilots Association (**www.aopa.org**)

UAS-based imagery

How can advances in this technology apply to **irrigated agriculture**?

By Lav R. Khot, PhD, and R. Troy Peters, PhD, PE, CAIS

Small and midsize unmanned aerial system (aka drone) technology has generated a perfect storm in the agribusiness industry for the past several years. To some extent, it has become a viable alternative to traditional crop scouting and farm operations monitoring. The drone industry has given an impression that everything is possible with this technology. This article is an effort to assess where we really stand when it comes to utilizing UAS imagery and its potential applications for irrigated crops monitoring and management, including specific examples from a Washington State University research team.

Platforms & imaging sensors

UAS is a somewhat established technology with various platforms available in the market. Such platforms allow repeated season-long mapping of entire field blocks through waypoint (GPS points) guided flight missions. Regulations have also eased to an extent that most agricultural farm areas can be flown, while in compliance with FAA Part 107 or with required certificates of authorization.

Active (with its own source of illumination) and passive (with sunlight as the source of illumination) optical imaging sensors can be integrated with a UAS. Various commercial RGB, multispectral, hyperspectral and thermal imaging sensors are available in the market. In general, sensor weight (payload), form factor, image capture rate for adequate overlaps (for fixed-wing UAS types) and field ruggedness have been the key barriers for quality UAS image acquisitions in agriculture.

Due to advances in optics and low cost, general crop scouting, inventory mapping and two-dimensional photogrammetry-based crop canopy characterization are becoming viable with UAS-based RGB imaging. Passive multispectral (3-10 bands) imagers that measure reflectance at specific bands (up to 1,000 nanometers) are also available commercially. Hyperspectral imaging, with hundreds of spectral bands, having narrow spectral resolution (typically < 30 nanometers), allows detailed soil and crop analysis in the ranges of 380 to 2,500 nanometers.

In terms of multispectral imagery data use, certain vegetation indices can be loosely related to nutrient deficiencies and water stress. They can identify the problematic area but cannot pinpoint specific reasons for crop stress unless additional field management or ground-truth data is available. Hyperspectral sensors can provide a higher level of reliability to detect early signs of crop stress; however, their form factor, weight and cost need to be commercially viable for broader adoption by the agricultural community. For each of these sensor types, calibration to account for changing illumination scenarios due to varied cloud covers is a challenge. Some ways to partially compensate for ambient light changes include the use of 1) a reference calibration panel for data normalization, 2) an integrated incident light sensor to account for sunlight variation, and 3) spectral ratios or vegetation indices during data interpretation.

Where do we really stand when it comes to utilizing UAS imagery and its applications for irrigated crops monitoring and management?

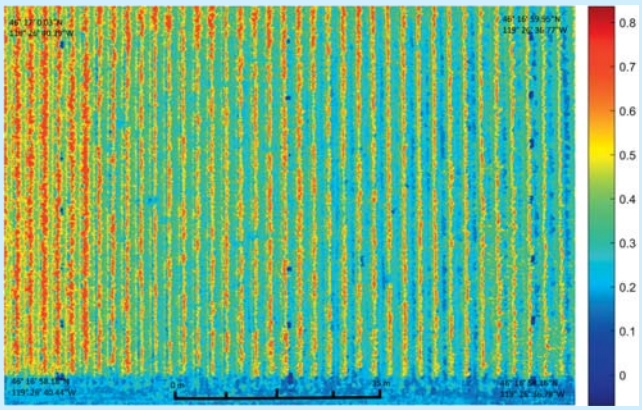


Figure 1. The small UAS (far left) gathers multispectral and thermal imaging of subsurface deficit-irrigated Cabernet Sauvignon grapevines. The resulting normalized difference vegetation index image (left) depicts vigor variations due to treatment effects at 45 days before harvest. (Project is funded by the Washington State Department of Agriculture-Specialty Crop Block Grant; investigators: P. Jacoby, S. Sankaran and L. Khot, Washington State University.)

Thermal imaging sensors capture an object's long wave infrared radiation using thermal detectors (i.e., micro bolometers). Thermal sensors with radiometric options acquire images with each pixel as a temperature data point. Thermal imagers' form factor and costs are decreasing rapidly. However, further improvements are needed for acquiring high-resolution and noise-free data. By nature, temperature change is very dynamic and can change swiftly due to wind or cloud cover. Moreover, sensor temperature can affect the accuracy of the data. Such data is harder to normalize and its interpretation in agricultural crop monitoring should be done cautiously.

Data analytics

A range of commercial solutions from offline post-flight data processing to the cloud-based data upload for storage, data processing and presentation are available. Some software can be purchased at a one-time cost (plus annual upgrades) or can be an annual subscription to data managers. Concerns related to online cloud-based services exist due to data ownership, privacy, and unintentional or without consent sharing of such data.

What does this mean for irrigated crop management?

Different sensors can be integrated with a UAS for scouting irrigated crops. It's the sensor output type that determines its suitability for a given application. For example, in irrigated fields (e.g., potato, corn, mint, tree fruit and grapevine crops), high-resolution RGB imagery can be used to determine the early signs of crop vigor variations.

A combination of multispectral and thermal imagery can also be used to determine crop water use and abiotic stress and to detect leaks in the irrigation system. Thermal imagery is especially useful for detecting crop water stress since plants that are not fully transpiring are relatively warmer than those that are.

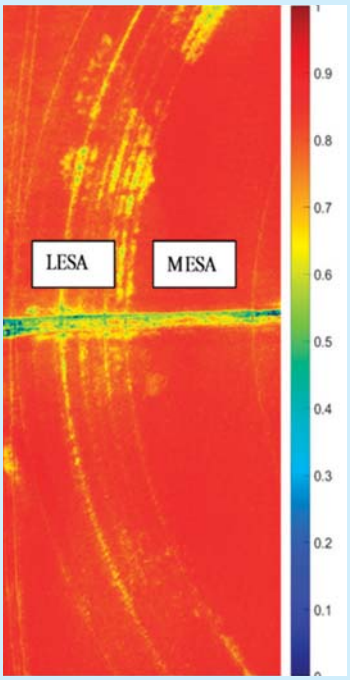
Drone imagery provides a high level of spatiotemporal data that suits many projects related to irrigation water-use monitoring. For example, as Washington State University teams retrofit or develop new irrigation techniques/methods suitable for a given crop and site, multispectral and thermal drone imagery was found to evaluate the site-specific suitability of such techniques (see figs. 1 and 2).

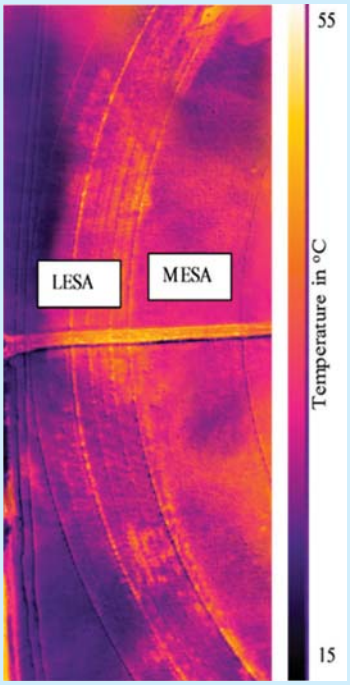
Overall, the domain of integrating various types of imaging sensors with small UAS is changing rapidly in terms of capabilities and cost. Major validation of these sensors for specific agriculture applications are needed for their meaningful use. The industry also needs to develop and offer robust sensor data analytics and processing to help growers in making more informed, real-time crop management decisions.

***Lav R. Khot, PhD**, is an assistant professor at the Center for Precision and Automated Agricultural Systems, Irrigated Agriculture Research and Extension Center at Washington State University.*

***R. Troy Peters, PhD, PE, CAIS**, works for Washington State University and serves as the extension irrigation specialist at the Irrigated Agriculture Research and Extension Center.*

Figure 2. A small UAS imaging low elevation and mid-elevation spray application irrigated corn on 134 days after planting (bottom left). The results include a thermal image (bottom right) and a normalized difference vegetation index image mosaic (below) of the study area. (Project is funded by State of Washington Water Research Center; investigators: L. Khot and R.T. Peters, Washington State University.)





Lower pressure for higher efficiency

Low energy precision application technology introduced a revolutionary concept in the mid-1980s when center pivot irrigators were mostly using top-of-pipe impact sprinklers operating at high pressures. Growers needed more efficient applicators that could irrigate at lower pressures to reduce pumping requirements. They also needed products and practices to combat wind drift and evaporative loss, especially in areas affected by declining water availability.

A collaboration between researchers from Texas A&M and sprinkler manufacturer Senninger Irrigation led to the development of the first LEPA applicator. Researchers found that LEPA sprinklers mounted near the soil surface provided beneficial water and energy savings without affecting yield.

In areas where water availability is a concern, growers looked again at the LEPA bubblers spaced with 40 inches or less between hose drops to distribute water over most of the soil surface. Senninger Vice President Mark Healy expanded his initial LEPA concepts to create bubbler pads and shrouds for these close-spaced LEPA installations.

In-field testing

The LEPA close spacing project began in Nevada. The climate is windy with little rainfall and very low humidity. The soil is heavy silt clay loam. John Maurer from Triple D Ranch in Dyer, Nevada, explains, "The groundwater basin here is depleting like most in any heavily irrigated area. It became a concern." Maurer was looking to reduce water loss to wind drift and evaporation and still maintain his yields. He went on to add, "When we started using these [LEPA close spacing bubblers] and saw what they would do to cut that out, that was a big motivation for me, because it's all about efficiency." He discovered LEPA close spacing bubblers with a shroud outperformed standard sprinklers over alfalfa. This past growing season, his LEPA installations produced an average of 21.5 percent more bales and 6.5 percent more tonnage during four cuttings on three pivots. The water rests on the soil surface and slowly infiltrates, producing lateral movement and leaching salts beneath the root zone.

Another project participant was grower Bob Holloway in Mingo, Kansas. The climate is windy with little rainfall and very low humidity. The soil is heavy silt loam. Holloway was able to farm 50 percent more corn, a total of 120 acres, with just 250-300 gpm thanks to LEPA technology. "The situation that we were in required us to either give up one irrigated circle or find a more efficient means of irrigating," he says. "With the LEPA bubbler system, we use the water we have available in a more productive way, resulting in less surface moisture and more beneficial subsoil moisture."

Irrigation dealers also see the LEPA close spacing benefits. Rick Grimes, owner of Southwest Irrigation in southwest Arizona, says that areas of Arizona and the Imperial Valley in California experience summer temperatures of 118°F to 120°F and evapotranspiration rates between 0.6 and 0.7 inches a day. As Grimes explains, "This means a farmer with 320 acres of land will need at minimum 12 gpm per acre just to offset the ET rates. LEPA sprinklers closer to the ground let growers irrigate more acres by reducing water loss."

Rod Stillwell with American Irrigation in Garden City, Kansas, was another participant in this project. Weather conditions in that area are usually windy and dry. According to Stillwell, "The main crops around here are corn, wheat, soybeans, milo, alfalfa and potatoes. With close spacing, growers are

LEPA close spacing on alfalfa in Dyer, Nevada
Photo credit: Senninger

LEPA close spacing irrigation project shows water & energy savings while increasing yields.

By
Jose
Fontela

A center pivot utilizing LEPA close spacing in Dyer, Nevada
Photo credit: Senninger

seeing that they can shut down their systems more often, therefore, saving water and energy. It's a cost-effective way to produce good yields."

Focus on results

LEPA close spacing installations, when combined with conservation tillage, average over 95 percent efficiency in water use. In addition to reduced wind drift and evaporation loss and less energy consumption, LEPA close spacing helps

- produce a more uniform root zone coverage.
- increase yield using less water.
- leach salts beneath the root zone.
- avoid wetting the plant canopy in row crops.
- apply the water needed in fewer pivot passes.

The participants in this project are confident LEPA close spacing will help growers in dry, windy areas around the world save water and energy and increase yields.

> *This close-spaced LEPA installations project was recently honored as the agriculture Vanguard Award winner during the 2017 Irrigation Show and Education Conference. This award is presented to honor a project that has executed an innovative installation project in the irrigation industry.*

***Jose Fontela** is a copywriter and digital marketing coordinator for Senninger Irrigation.*

July is right around the corner!

Make plans now. Join the Smart Irrigation Month campaign.

By Elizabeth McCartney
Irrigation Association Senior Policy and Advocacy Manager

Each July, irrigation industry companies and professionals have the opportunity to come together and carry the message about the social, economic and environmental benefits of efficient irrigation. 2018 will be no different. Join this industry effort to grow demand for efficient irrigation technologies, products and practices by participating in Smart Irrigation Month this July.

Smart Irrigation Month 2018 will officially kick off with Irrigation Technology Tuesday on July 10. This is a great day to use social media to amplify the industry's voice by highlighting water-efficient technologies. The following ideas will help you plan now for how your company will get involved in promoting Smart Irrigation Month.

1. **Incorporate messaging into marketing** – Companies can leverage Smart Irrigation Month to stand out and grow their businesses. If there is a new product or practice to highlight, industry companies and professionals can do this under the banner of Smart Irrigation Month. Companies can incorporate the smart irrigation message into any marketing planned for July. Be sure to visit the website and download the Smart Irrigation Month logo to include on any marketing materials.

What you need to know!

- Kick it all off with **Irrigation Technology Tuesday** on **July 10**. Make a splash on social media!
- Use **#SmartIrrigationMonth** on your favorite social media platform to help promote the importance of efficient irrigation.
- Go to **www.smartirrigationmonth.org** for more information, tips and resources.

2. **Increase public awareness** – Smart Irrigation Month also offers the entire irrigation industry the opportunity to collectively spread the word about the incredible importance of using water efficiently, while promoting the value of irrigated agriculture. Efficient irrigation offers year-round benefits for agriculture, but as pressure grows to reduce water consumption, the story must be told about how efficient irrigation can help minimize the amount of water lost to runoff and evaporation. Smart Irrigation Month is the perfect time to increase public awareness about how smart technologies and practices allow growers to conserve water, as well as provide the potential for increased yields.

JULY SMART IRRIGATION MONTH

3. **Engage with policymakers** – The agricultural irrigation industry faces its own unique water challenges. The Irrigation Association will again leverage Smart Irrigation Month to make sure legislators also understand the benefits of irrigated agriculture. With Congress currently working on the 2018 U.S. Farm Bill and a comprehensive infrastructure package (see related article on pg. 8-9), it is a critical time to discuss how efficient irrigation offers year-round benefits for agriculture. Engaging with policymakers is just another way to participate in Smart Irrigation Month. At the state and local levels, those in the irrigation industry continue to encourage governors and community leaders to officially proclaim July as Smart Irrigation Month.

The Irrigation Association provides resources and ideas about how to get involved on its website, **www.smartirrigationmonth.org**. Don't let Smart Irrigation Month come and go without celebrating and promoting the many benefits that efficient irrigation has to offer.

Farm competition yields interesting water-use results

By George Oamek, PhD

It's no secret that irrigators make a lot of water-related decisions in order to profitably grow a crop, but many other nonwater decisions can equally affect profitability. A group led by Daran Rudnick, PhD, an assistant professor and irrigation management specialist at University of Nebraska – Lincoln's North Platte Research and Extension Center, has developed a competitive approach to demonstrating this and to begin developing a database that addresses the interactions of the numerous decision variables. In addition to UNL, his supporters include Aquamart and the Nebraska Water Balance Alliance, both local organizations concerned about water stewardship and the long-term sustainability of irrigation.

The success of the Farm Management Competition in 2017 has guaranteed that it will be back in 2018.

The competition

As part of the UNL-TAPS Program (aka Testing Ag Performance Solutions), the first annual Farm Management Competition held in 2017 was a contest where participants, either individuals or groups, competed in the production and marketing of corn. Each team, or farm, competed for three possible awards, the most prestigious being the most profitable farm, followed by an award for water and nitrogen use efficiency and another for highest yield. Competitors made real-time decisions about irrigation management with respect to volume and timing of application, nitrogen management, seed hybrids, seeding rate, grain marketing and purchase of crop insurance.

There were 15 teams involved, consisting of individual producers or groups of producers in Nebraska's Platte and Republican River Basins. The competition took place on a 40-acre parcel located at the North Platte Research Center. Each "farm" on paper included 3,000 harvested acres for purposes of making management decisions. The decisions made by each team for their respective farm were applied to three randomized plots within the research center's quarter section, averaged and extrapolated over 3,000 acres. The winner of the most profitable farm was awarded $2,000, the most input-efficient farm received $1,000, and highest yielding farm received $500.

Control groups were managed by the UNL folks and included 1) a parcel that was not irrigated and was not fertilized, 2) a parcel that managed these inputs in a manner that ensured neither water or nitrogen would limit yields, and 3) a parcel that intentionally limited water and nitrogen in a highly managed manner.

Differences in desired irrigation and nitrogen application rates were implemented through technology:

- A center pivot sprinkler with a variable rate irrigation package allowed for each nozzle to function independently with respect to rate and field location. This gave each participant the opportunity to manage water application themselves and apply up to an inch of water twice per week during the growing season, as desired.
- Irrigation decisions were aided by soil moisture probes providing continuous moisture levels for each plot, accessible to participants over a project website.
- A variable rate fertigation system gave the participants the option to apply a portion of their nitrogen with their irrigation water. All teams using nitrogen took advantage of this.

Results

Profits ranged from -$153 to +$146 per acre, demonstrating how different, yet reasonable, combinations of inputs and management decisions affect profitability. The results were not universally conclusive with respect to water and fertilizer usage, which was valuable information in itself. It demonstrated that other decisions, like marketing strategies, hybrid selection and seeding rates were equally critical in farm profitability. However, generally the more profitable combinations featured about 25 percent less nitrogen application, with more fertigation and side-dress applications relative to preplant applications. There were

For more information about UNL-TAPS 2017 Farm Management Competition and competitions planned in 2018 —

a couple of exceptions to this, but it does reinforce that better timing of nitrogen can result in less usage.

For water usage, the most profitable farm ($147 per acre) applied slightly more water than needed compared to the nonlimited control group, suggesting that more precise measurement and application may be cost effective. Although this farm did not have the highest yields or the lowest costs, it used an aggressive marketing strategy to forward contract a portion of the crop and to reduce its transportation cost to market compared to other participants. Score one for the marketing economists!

Most interesting for the production economist (me) is that the second most profitable farm ($137 per acre) was the limited water and nitrogen control group, making a strong case for managed-deficit irrigation. With 50 percent less irrigation water and 15-20 percent less nitrogen, it yielded only 4 percent less than under unlimited conditions. No doubt that some timely rain helped to minimize the yield reduction due to deficit irrigation, but it does show that irrigated agriculture in this region can be pretty resilient with respect to reduced water usage.

The success of the Farm Management Competition in 2017 has guaranteed that it will be back in 2018, with additional sponsorships from the water industry. For this upcoming year, a buried drip system will be installed as a measure to introduce alternative irrigation technologies into the decision process. The competition has been a highly useful demonstration and data collection effort — and a good measure of fun, as well.

***George Oamek**, PhD, is an economist with Headwaters Corp. and is also on the staff of the Platte River Recovery Implementation Program's executive director's office.*

visit https://taps.unl.edu.

Busy 2018 for NGWA

Association works to raise awareness & advocate for responsible use of water

By Terry Morse

It was a busy year for the National Ground Water Association and the groundwater industry in 2017, and so far, 2018 shows no signs of slowing down. Emerging contaminants, the arid West and Southwest, global water shortages, aging infrastructure and the impact of climate change on groundwater are all hot-button issues prevalent in the news and widely discussed by our members.

Since our inception, NGWA's mission has been to advocate the responsible development, management and use of water. While this covers a broad range, our global membership is dedicated to protecting this resource.

In 2017, one of the bigger stories regarding groundwater was the continued, and potentially increased, presence of per- and polyfluoroalkyl substances. These man-made, emerging contaminants dominated headlines from the Wolverine/3M Superfund site in Rockford, Michigan, to individual states such as New Jersey taking a hard look at what constitutes safe levels of the contaminant in water.

NGWA developed and released ***Groundwater and PFAS: State of Knowledge and Practice*** in late 2017. A 12-month effort by 36 volunteers spending 1,100 hours, this comprehensive eight-part guidance document explores these potentially hazardous compounds in groundwater and soil. The document summarizes the fate, transport, remediation and treatment of PFAS, as well as current technologies, methods and field procedures.

A few months into 2018, PFAS remains a fixture in the news, and the conversation around these compounds will continue into the foreseeable future.

Water scarcity around the world, and at home in the western United States, remains a challenging and eye-opening issue. The Ogallala (or High Plains) Aquifer, which underlies parts of eight states, serves a large part of the world's food production with more than 90 percent of the groundwater pumped from it used for irrigation. Farmers in these states have a right to this water that is critical to their livelihood, but as the demand for water continues, so do drought conditions in the arid West, a combination that is taxing this groundwater resource.

In late February, NGWA held a **conference focused on groundwater** availability, use, policy and management in the southwestern states of Arizona, California, Colorado, Nevada, New Mexico, Texas and Utah, as well as surrounding environs. During the event, attendees discussed the latest research and initiatives regarding sustaining local water resources and stressed the need to work together to collectively protect groundwater.

NGWA appeared on RFD-TV earlier this year to discuss the delicate balance between irrigation and water levels in the West and will continue to raise awareness through traditional and social media outreach throughout the year.

Speaking of outreach and raising groundwater awareness, we were honored to partner with the Irrigation Association and the Water Quality Association for the **NGWA Fly-in and Water Resources Congressional Summit** in Washington, D.C., March 6 and 7. The event helped ensure members of Congress are aware of the important role groundwater plays in providing drinking water, supporting agriculture and fueling various sectors of our economy. While the event may be over this year, our government affairs team will continue advocating for our collective rights on the Hill, and I certainly encourage each of you to do the same.

As a parting thought, I want to thank those of you who participated during this year's **National Groundwater Awareness Week**, March 11-17, a grassroots effort that continues to grow and make a difference. Folks from across the country shared their stories on social media and through our event website, **www.groundwaterawarenessweek.com**. The site will remain active throughout the year, so feel free to continue using the resources and sharing your groundwater stories. And, don't forget — **Protect Your Groundwater Day** is right around the corner on Sept. 4, which is another opportunity to spread the word about the resource.

2018 is already a busy year for groundwater; collectively we can make a difference. After all, we truly are better together.

Terry Morse *is the chief executive officer of NGWA. He is an association management veteran and is committed to enriching the membership experience and furthering the association's mission.*

To read an overview of the NGWA's *Groundwater and PFAS: State of Knowledge and Practice* document, go to **www.ngwa.org/pubs/Documents/bookstore/pfas-doc-section1-overview.pdf**. The comprehensive document is available at no cost to NGWA members, and nonmembers may purchase it through the NGWA online bookstore.

Irrigation reform in Moldova

Long-term plan to rebuild irrigation systems and put management in the hands of water users.

By Gary Merkley

The Republic of Moldova is a small, land-locked Eastern European country situated between Romania and Ukraine. The country has a rich agricultural history, but most of the agricultural irrigation systems fell into disrepair in the years following the collapse of the Soviet Union.

By the mid 1980s there were over 70 state-built and state-managed irrigation systems, almost all of which pumped water from either the Prut or Nistru Rivers along the western and eastern borders, respectively. Pumping is necessary to lift water to the fields due to the undulating topography of most of the country and the low longitudinal bed slope of the rivers. The energy required to pump the water represents the major operational cost for irrigation. With the hilly topography, almost all irrigation is by pressurized methods, with some microirrigation but mostly sprinkler irrigation. Several types of sprinkler irrigation have traditionally been used in Moldova, and currently there is an emphasis on traveler systems.

The Transition to High Value Agriculture Project under the Millennium Challenge Corporation's compact program in the Republic of Moldova was designed to redesign and rebuild selected irrigation systems and turn over its management to water users' associations (known as WUAs) whose membership included local farmers. By economic standards, some of the irrigation systems had such a high pumping lift that continued operation could not be justified, and those were among the systems that were excluded from the project. Of the remaining systems, 11 were selected.

Tour of a new irrigation system pump station in Criuleni, Moldova

From 2010 to 2015, Euroconsult Mott-MacDonald implemented the Irrigation Sector Reform Activity, which was one of four components to the Transition to High Value Agriculture Project. The Irrigation Sector Reform Activity included two subactivities: Irrigation Management Transfer and River Basin Management. Through the Irrigation Management Transfer subactivity, the project established and legally registered 11 irrigation WUAs, providing participatory organizational development and institutional strengthening services through capacity building and more than 40 different training topics. The associations were each associated with a "central irrigation system," representing a total area of 15,000 hectares of farmland. The central irrigation systems were formerly managed by the federal government, but under this project the management of 11 of the systems was transferred to the respective WUAs for a 30-year period. This approach followed international best practices in irrigation water management.

The River Basin Management subactivity consisted of a series of major tasks designed, in part, to support the sustainable operation of the newly rehabilitated irrigation systems and their WUAs. This included legislative reform, water resources monitoring, rating-curve development, and the establishment of a water resources decision-support system. The legislative reform involved the drafting of a new water law, support for the official approval process, and the development of four regulations for the implementation of the new law. Three common platforms were developed, including an internet-based "one-stop shop" for water-use authorizations and two relational databases. Eight new real-time water monitoring stations were installed at key locations along the Nistru River and some of its tributaries, and hydrological surveys were undertaken with Moldova's State Hydrometeorological Service to develop new rating curves, which established a

relationship between water level and flow rate at each site. The water resources decision support system is based on hydrometric data management software, hydrological and hydraulic modeling software, and real-time water monitoring.

The main focus of the Irrigation Management Transfer subactivity was about capacity building for the WUAs, especially after they had been created and legally registered. All 11 WUAs were legally registered early in 2012, and capacity-building services were offered to the WUAs. Eight thousand participants attended 725 capacity-building events, with almost 10,000 person-days of instruction. The project dealt with numerous related issues, including legal concerns, dealing with local public authorities, fiscal reporting, registration of lands and buildings in the central irrigation system, human resources and the labor code, and various others.

For the WUAs and their members, the number of concurrent activities was sometimes overwhelming, so it was necessary to assist with communications, coordination and scheduling of events to minimize concentrations during some periods. To this end, the Irrigation Sector Reform Activity consultant frequently updated its work plan to accommodate the WUAs and other project implementers.

By the end of August 2015 three of the WUAs had collected 100 percent of the annual membership fees for 2015, and three others collected more than 80 percent. These are impressive statistics, considering that most of the WUAs had not yet begun to manage an operational irrigation system, and only a few of the farmers had irrigation water application equipment at the time. It demonstrates the serious commitment of the land users to irrigation system management, and it reflects well on the organizational development assistance and institutional strengthening provided through the Irrigation Sector Reform Activity.

Nine of the 11 active WUAs have demonstrated that they are better prepared and more capable of managing the rehabilitated central irrigation system than the Apele Moldovei agency's regional state enterprises, with a solid business approach, financial and operational transparency, and understanding of the tasks that need to be accomplished to become durable, self-sufficient associations.

***Gary Merkley**, senior supervising engineer at Natural Resources Consulting Engineers Inc., has over 35 years of professional engineering experience in the United States and more than 20 other countries, with a background in farming and agricultural business. He is an author and editor and has worked as a technical specialist on overseas assignments.*

9 *of the* 11 active WUAs have demonstrated that they are better prepared.

CAIA announces fall meeting

The California Agricultural Irrigation Association invites irrigation industry representatives and other interested parties to the CAIA 2018 Fall Meeting, Sept. 5-7, at the SeaCrest OceanFront Hotel in Pismo Beach, California.

Highlights include

- a legislative/regulatory roundtable where state and federal legislation, new and changing regulations, and other issues affecting agriculture and irrigation will be discussed.
- technical/educational sessions featuring presentations on special projects/research and innovations in the agricultural irrigation industry.
- the member meeting with keynote speaker.
- an educational tour of a local/regional agriculture operation.
- a golf tournament.

CAIA members and non-members are welcome to attend. Meeting information and registration materials will be available in early summer on the CAIA website at **www.calirrigation.com**.

WG showcases irrigation technology at agtech event

Western Growers recently hosted Innovation in the Imperial Valley, a "backyard" summit where nearly 200 farmers, researchers, technologists and agtech startups came together to delve into the water and labor issues facing Imperial Valley agriculture and the specific technologies being invented to help solve those issues. The event included field tours to learn about existing automation; in-depth panels on water technology and mechanization; fireside chats on bringing a product to market; and pitches from startup companies who are inventing solutions such as new technologies to tackle irrigation inefficiencies. Innovation in the Imperial Valley is part of WG's latest effort to advance innovation by bringing agricultural technologies to farmers, in their backyard. To see more agtech events, visit **www.wginnovation.com/events**.

NGWA promotes Groundwater Awareness in March

On March 11-17, the National Groundwater Association celebrated National Groundwater Awareness Week. This annual observance highlights the responsible development, management and use of groundwater. The event is also a platform to encourage yearly water well testing and well maintenance to prevent waterborne illnesses.

The NGWA also headed to Washington, D.C., on March 6-7 for the 2018 NGWA Groundwater Fly-in and Water Resources Congressional Summit to engage with policymakers and other groundwater professionals on issues impacting your business.

FFA holds annual meeting & conference

Nearly 250 people attended the 2018 Family Farm Alliance Annual Meeting and Conference in February at the Eldorado Resort Casino in Reno, Nevada. Mitzi Wertheim, professor at the U.S. Naval Postgraduate School, suggested ways to build the foundation for horizontal communications and solutions to complex water problems. Featured keynote speakers included Deputy Interior Secretary David Berhardt; Kiel Weaver, policy advisor to House Speaker Paul Ryan; and Brenda Burman, commissioner of the Bureau of Reclamation.

Four of five Reclamation regional directors also spoke at the conference, as well as Robert Harper, director of water, fish, wildlife, air and rare plants for the U.S. Forest Service; Paul Souza, U.S. fish and wildlife regional director for California/Nevada; and key congressional water committee staff.

Key discussion panels focused on connecting consumers with producers, developing creative ways to address the Endangered Species Act, seeking a sustainable balance of economic prosperity and environmental protection in the West, and updates on recent Bureau of Reclamation initiatives related to its policies and technical services. Representatives from the Association of California Water Agencies, California Farm Bureau and The Nature Conservancy recapped the 2017 wildfire season and political efforts underway to improve forest health.

Ag faculty event open for registration

The Irrigation Foundation is offering its popular agriculture version of the Faculty Academy June 25-26 at the Agricultural Research, Development and Education Center in Fort Collins, Colorado. This annual event is free to attend and is open to instructors teaching at high schools and two- and four-year institutions. Attendees return year after year to network and learn the latest irrigation-related curriculum. To register or for more information about the sessions, schedules and tours, go to **www.irrigation.org/facultyacademy**.

Exposure, experience & education for students & instructors

Mark your calendars! In May, applications will be accepted from students and instructors for the Irrigation Foundation's Irrigation E3 program. This annual initiative focuses on providing irrigation industry exposure, experience and education to students and instructors. Those accepted are provided with an education and travel award to the 2018 Irrigation Show and Education Conference in Long Beach, California, Dec. 3-7. For more information, go to **www.irrigationfoundation.org/E3**.

WQA Executive Director Pauli Undesser, IA CEO Deborah Hamlin and NGWA CEO Terry Morse at the 2018 Washington, D.C. Fly-in.

Irrigation industry heads to D.C.

The irrigation industry made its mark on Capitol Hill March 6-7 during the **Irrigation Association**'s 2018 Washington, D.C. Fly-in, held in conjunction with the **National Ground Water Association** and the **Water Quality Association** during the Water Resources Congressional Summit. During the two-day event, 13 IA members joined IA staff and met with elected officials to discuss key issues affecting irrigation such as the farm bill and irrigation infrastructure.

Irrigation ASSOCIATION®

Irrigation Show registration opening soon!

The irrigation industry is headed to the relaxing West Coast for the 2018 Irrigation Show and Education Conference. Make plans now to attend this one-of-a-kind irrigation trade show and week-long education conference Dec. 3-7 in Long Beach, California. Registration opens in June; don't miss discounted rates for early registration. For more information, go to **www.irrigationshow.org**.

IA completes ag job analysis

The Irrigation Association conducted a certified agricultural irrigation specialist job analysis in January in Dallas, Texas, to assess the duties of an agricultural irrigation specialist to ensure that the CAIS exam is assessing the skills needed to do the job right. Conducting job analyses ensures that the IA exams are legally defensible and based on what individuals within the profession do in the field and how they apply their knowledge.

IA drip webinar scheduled for October

Mark your calendars for the next IA ag irrigation webinar on Oct. 3, at 3 p.m. Eastern. Kansas State University's Jonathan Aguilar, PhD, and Danny Rogers, PhD, will present the session titled Mobile Drip Irrigation Demonstration Results.

Registration will open soon, and participants earn 1 CEU. For more information, go to **www.irrigation.org/webinar_series**.

Bringing Water to Life podcast series

Accessible through iTunes, Spreaker, Stitcher, Google Play and iHeartRadio, BWTL is a weekly podcast driving more discussion about water. For more information, go to **www.bwtlpodcast.com**.

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Early look at U.S. summer weather

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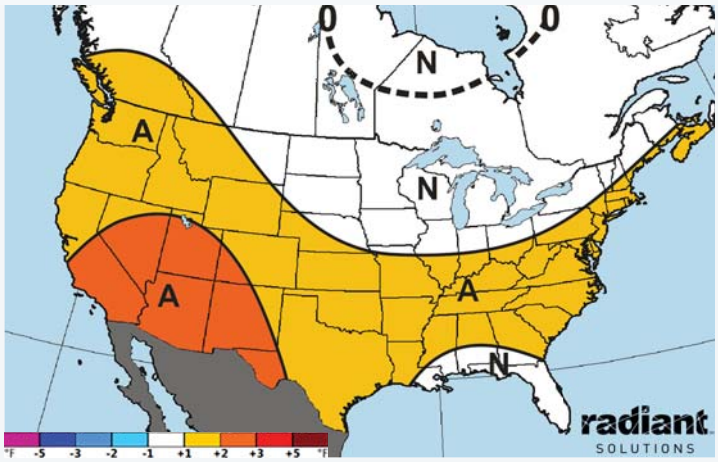
A hotter than normal summer is expected across most of North America this year, with the strongest heat relative to normal favoring the western United States. Across the Corn Belt, however, temperatures are expected to be only slightly above normal, which would limit the potential for significant heat stress in the major corn and soybean growing areas. The best potential for any heat stress for crops this summer would be found across the southwestern Plains.

The precipitation outlook for this summer is fairly benign across the central and eastern United States. Near normal rainfall is expected across most of the Corn Belt, with slightly above normal rainfall expected across the east central Midwest. Wetter than normal weather is also possible across the southern Delta. Below normal rainfall is expected across the western United States, with some of that dryness possibly expanding into the northern Plains and the Canadian Prairies, which could stress spring wheat, canola and pulses. Given the drought conditions currently in place across the western Plains, there is a dry risk to the forecast in this area. The expected transition away from La Niña and the potential move toward El Niño late this year support the Radiant Solutions forecast for relatively benign summer weather across the central United States.

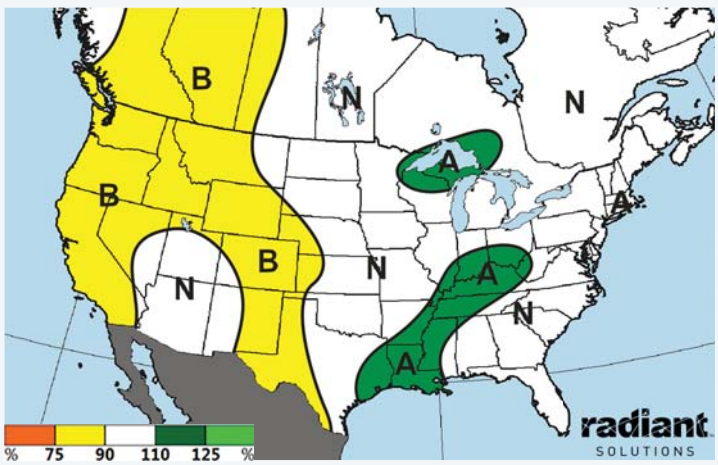
Radiant Solutions summer temperature forecast

(A = above normal, B = below normal, N = normal, 0 = zero – the dividing line between negative and positive temperature anomalies)



Radiant Solutions summer precipitation forecast

(A = above normal, B = below normal, N = normal)



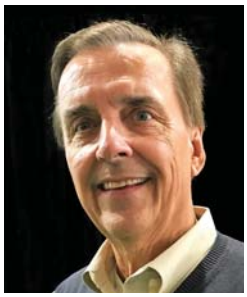
Industry insights

At the recent World Ag Expo in Tulare, California, *Irrigation Today* caught up with a few irrigation industry representatives and asked the following question:

How do you see agricultural irrigation changing the most over the next 10 years?

"For me, the biggest change will be the way we monitor — the information that we are looking at, where we are looking at it, why we are looking at it and how we are looking at it. So, are we using moisture monitoring or are we doing old-school hand methods? Are we going incredibly into telemetry and remote data access? I think those are going to be the biggest changes probably over the next 10 years."

JACOB MORENO | IRROMETER COMPANY INC.



"It will be evolving, but more importantly, the adoption will continue to increase because of a) the scarcity of water, and b) when we deliver water right, not only will we get more consistent yield and quality, but the nutrient management program works so much better in the soil, and when we irrigate more effectively we have less disease pressure. So, when we do the right things right with water, the crop is much happier. The future looks really bright!"

MIKE THUROW | SPECTRUM TECHNOLOGIES INC.

"Sensor capacity — soil moisture sensing, field monitoring, mechanized irrigation, drip systems getting away from flood irrigation, gated pipe irrigation, moving to more modern technologies, and taking technologies from the turf industry that have been around for a number of years (including Wi-Fi, remote monitoring, remote application) and applying those to ag irrigation."

JOHN JOHNSTON | SENNINGER

Ad index

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