By Larry Reichenberger

Living with less water

Irrigated growers are learning new tactics to manage dwindling water supplies

Making more with less has become an obsession among irrigated farmers in the Great Plains. Thanks to dwindling water supplies, skyrocketing pumping costs, and nagging water use restrictions, many producers are undergoing significant management changes in order to conserve water resources.

"It's a new era of water-limited crop production in which growers are challenged to reduce water loss and increase water use efficiency while still trying to maximize their net return," says Suat Irmak, water resources specialist at the University of Nebraska.

A team approach. Nebraska farmer Jerry Stahr knows he's blessed—the ground water level in his south central Nebraska area (Upper Big Blue Natural Resources District) hasn't fallen to the point where water use regulations would apply, as has happened in other parts of the state. "Last year we were within a foot of triggering water use regulations. We don't want that to happen, so we're doing all we can to reduce our water use," says Stahr.

In 2005, Stahr was one of 18 producers to join the Nebraska Agricultural Water Management Demonstration Network, a group started by Irmak in conjunction with county Extension educators Gary Zoubek, Jenny Rees, and Brandy VanDeWalle, along with officials from the Upper Big Blue NRD. The group's goal is to increase adoption of new technologies to help farmers conserve water and reduce energy costs associated with irrigation.

Zoubek, who helps to coordinate the network, says participation grew to include 130 cooperators last year (after the effort went statewide) and is expected to reach 200 this season. "In this program, cooperators learn to track their crop water use by measuring evapotranspiration (using an ETgage atmometer) while also recording soil moisture levels (using Watermark sensors buried 1- to 3-feet deep). The information allows them to target their crop's water requirements more precisely, which reduces water use, saves pumping costs, and avoids leaching fertilizer and chemicals into the groundwater," says Zoubek.

A recent survey of network cooperators shows the network is having a major impact. Almost all of the 50 cooperators who responded to the survey said the monitoring effort was influencing the amount of irrigation water they applied.

"Corn producers estimated they saved an average of 2.6 inches of water with savings ranging from 0 to 7.5 inches in 2007. The savings on soybeans averaged 2.1 inches and ranged from 0 to 4.8 inches," says Zoubek.

To put that in perspective, Irmak points out that there are about 12,000 irrigation wells in the Upper Big Blue NRD. "Reducing water use by 1 inch would save 27.1 billion gallons of groundwater. And, at current diesel fuel prices, it would save more than $5 million in pumping costs," he says.

Savings early and late. The ETgage and Watermark sensors used by network cooperators cost about $600. In many cases the local NRD (Natural Resources District) shares in that cost.

Stahr checks his ETgage, which mounts on a telescoping pole to adjust to the top of the crop canopy, at least once a week. "It's like checking the rain gauge, but in reverse," he says.

The device actually mimics the absorption of solar radiation by plant leaves. It displays the amount of water wicked up from the unit's reservoir in a sight gauge on the side.

"If the gauge tells you 2 inches of water was used in five days, then you correlate that with the growth stage of the crop to determine the amount of water needed," explains Irmak. "You then subtract any rainfall received, and that allows you to come up with the amount of irrigation required."

One of the benefits of the system, according to Zoubek, is that it emphasizes the fact that crop water use varies by growth stage. "At the four-leaf stage you multiply the ETgage reading by .18 to determine water use—a 2-inch reading would require .36 inches of water. But at silking, the multiplier is 1.1, so a 2-inch reading would require 2.2 inches of irrigation," he says.

Network participants install soil moisture sensors near the ETgage in their field. Attached to PVC pipes, these sensors are buried at 1-, 2-, and 3-foot depths. A data logger provides a record of the readings and a handheld unit can be used to take this information to a computer for graphing.

"The greatest potential for savings that we see is at the end of the growing season," says Stahr. "We want to finish with a dry soil profile—so there's room to absorb winter and early spring precipitation—but we don't want to stress the crop late in the season and trim the yield. The monitoring equipment makes it easier to perform this balancing act."

Alan Songster, who farms near McCool Junction, Neb., participated in the

►**Left:** Jerry Stahr is one of a group of Nebraska farmers learning to use ETgage atmometers to fine-tune irrigation scheduling decisions.

►**Below:** Irrigation specialist Norm Klocke says crop residue covering the soil surface reduces evaporation even under a crop canopy.

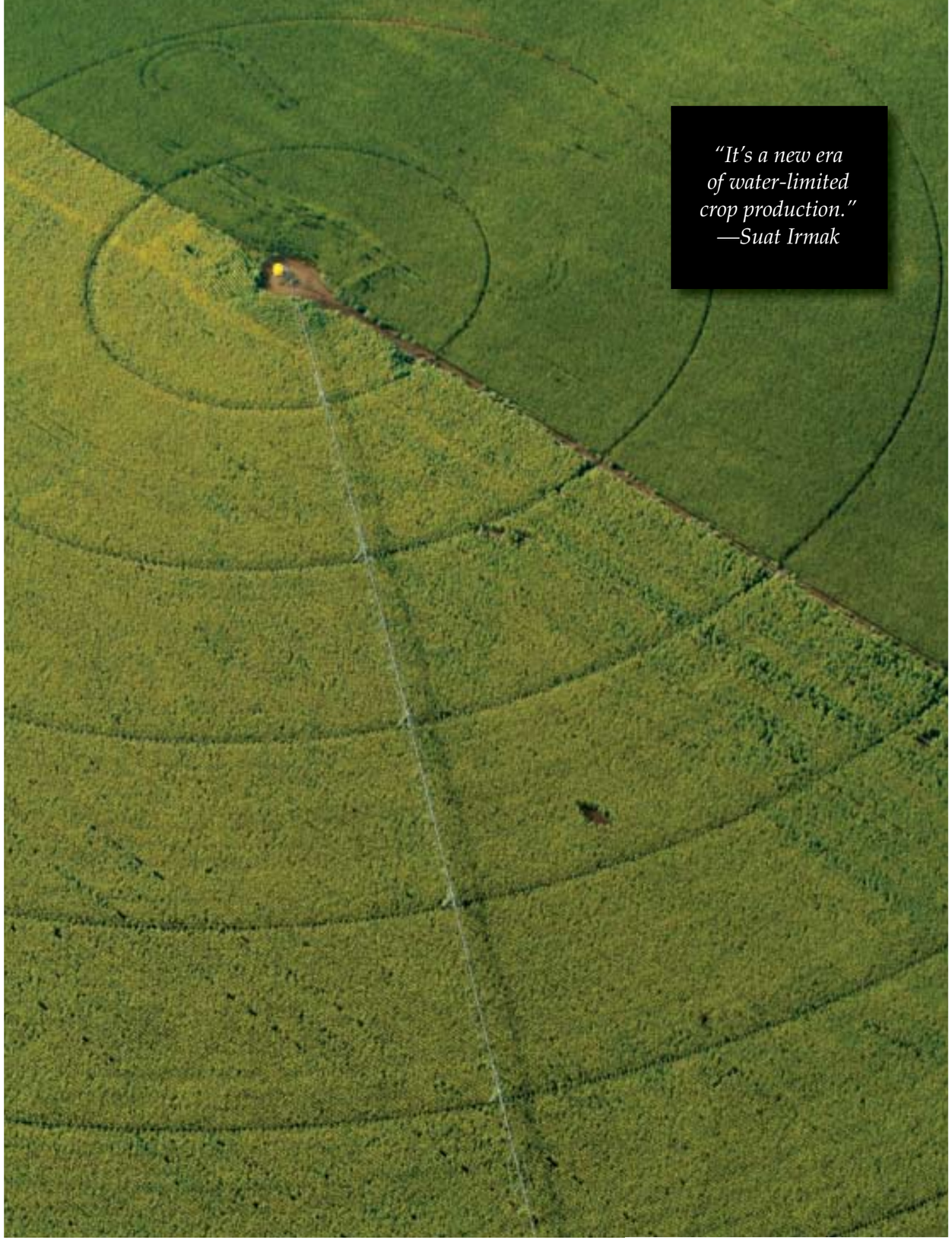
Water Management Network for two years and says he plans to begin using atmometers and soil moisture sensors in more of his irrigated fields this year. "The equipment costs about $600 and it costs us about $1,000 to pump an inch of irrigation water through a center pivot," Songster points out. "I'm confident we can reduce the amount of irrigation water we pump by an inch and pay for the equipment in a single season," he says.

Residue saves water. In many areas of the Great Plains irrigation water is already in short supply, prompting allocation levels often below normal crop demands. This "deficit irrigation" situation challenges users to make the most of limited water. Obviously, less water means less income, but the good news from researchers is that, under proper management, a 25% to 50% reduction in water application only reduces income by 10% to 20%.

"When there is not enough water to produce full yields, the goal is to maximize transpiration, which correlates directly with grain production, and minimize evaporation, which is non-essential water loss," says Norm Klocke, water resources engineer at Kansas State University's Southwest Research and Extension Center.

Klocke says one of the best ways for growers facing deficit irrigation to control evaporative losses is to copy the no-till practices of their dryland neighbors. "Crop residue on the surface reduces soil evaporation, even under a canopy of growing corn. In western Kansas we've found that, over a 110-day growing season, the moisture savings amount to 3 inches when residue cover is 80% to 100%."

"In addition, crop residue increases soil moisture stored during the non-growing season," he says. "Research in eastern Colorado and western Nebraska has shown this amounts to another 2 inches, so total water savings from using no-till is about 5 inches."



"It's a new era of water-limited crop production."
—Suat Irmak

►**Right:** Kansas State's Crop Water Allocator, and other decision tools, help farmers optimize crops, acreages, and water allocation strategies.

►**Above:** Soil moisture sensors, buried 1-, 2-, and 3-feet deep, help Alan Songster optimize irrigation at the beginning and end of the season.

Klocke explains that, depending on the situation, the ability to shift 5 inches of water to transpiration can produce an impact on the bottom line.

"In a fully irrigated scenario, that's 5 inches you don't have to pump. At a pumping cost of $9 per acre-inch that's a savings of $45 per acre. However, where the irrigation system can't meet the full water needs of the crop, the benefits are even greater. Corn yields increase about 10 bushels per acre for each inch of irrigation, so the 5-inch savings would add 50 bushels to the yield, or $225 per acre at a corn price of $4.50 per bushel," he says.

In research completed last year at K-State's Northwest Research-Extension Center, irrigation engineer Fred Lamm found that strip-tillage can also help farmers get the most from limited irrigation. "We compared conventional-till, strip-till, and no-till corn at irrigation capacities of 1-inch applied every 4, 6, and 8 days. Over four years, the strip-till tended to have the highest grain yields and this effect was greatest at the lowest irrigation capacity. In that situation, it topped conventional-till by 13 bushels per acre and no-till by 4 bushels when the planting rate was 30,000 seeds per acre."

Complex choices. Management becomes complicated when water becomes limited. Growers must decide if they should grow different crops, irrigate fewer acres, apply less water to existing crops, or combine these strategies for the best economic outcome.

Irrigation experts in several Great Plains states have developed computerized decision tools to help make these complex choices. The Crop Water Allocator, from Kansas State (*www.oznet.ksu.edu/mil*); Water Optimizer from the University of Nebraska (*http://real.unl.edu/h20/*); and Colorado Crop Water Allocation Tool, found under the resources tab at *http://limitedirrigation.agsci.colostate.edu* help growers optimize their strategies. ■