Wireless Watering

New irrigation technologies from ARS can help conserve a vital resource.

In the small farming town of Sidney, Montana, Robert Evans adjusts his Bluetooth. He's not chatting with colleagues or closing a business deal. He's watering his fields.

A research leader at ARS's Northern Plains Agricultural Research Laboratory, Evans is using the latest in wireless communications technology to boost irrigation efficiency. Thanks to Bluetooth and a wireless network of small soil-moisture and temperature sensors, the field in front of him is able to continuously dictate its exact water needs. Signals sent to an irrigation station tell individual sprinklers just how much water to emit and where.

This system, the ultimate in high-tech precision irrigation, was built around the concept that most agricultural fields are filled with environmental nuance. Because of factors like soil type, subsurface conditions, topography, drainage issues, and disease problems, a piece of farmland that looks uniform on the surface is, in reality, a complicated, irregular patchwork of smaller plots, each defined by its own set of problems.

That's why an automated irrigation system like this one—which doesn't dole out a drop of water anywhere unless told to—is so critical to efforts to conserve the world's water and fertilizer supplies.

"Right now, most growers, for the most part, are only able to manage their fields with just one soil type or problem in mind," says Evans, an agricultural engineer. "They may be irrigating for sandy soil, which requires more water, when in fact they have clay soil too."

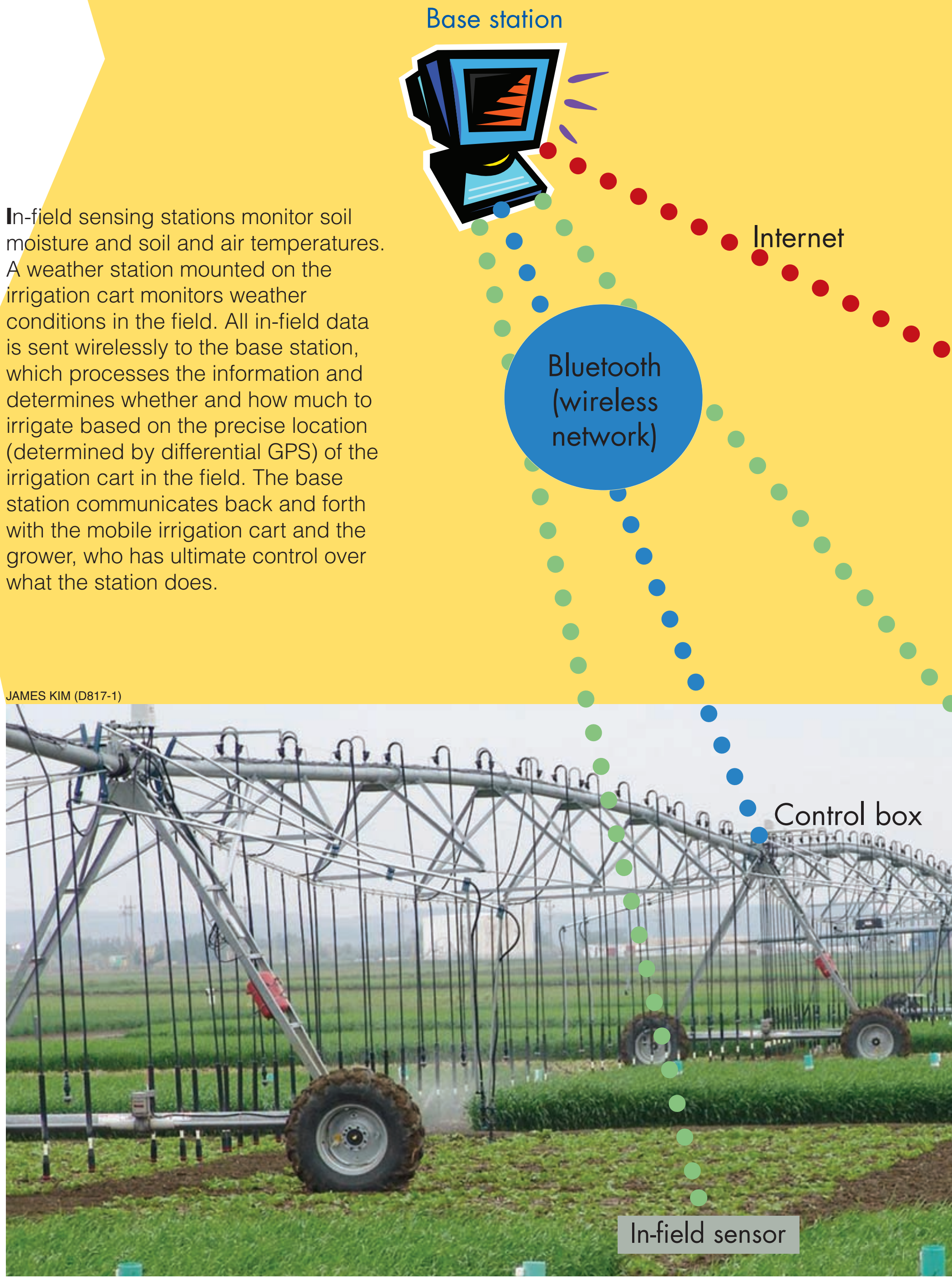
Because that clay soil retains moisture, an amount of water that is perfect for the larger grained sandy soil would likely be wasted in runoff from a clay soil and could lead to drainage and plant-disease problems.

Meeting Diverse Demands

There's a reason that Evans and his ARS colleagues from across the country are so focused on building water-saving irrigation systems.

High-tech Irrigation System

- water-saving
- wireless
- automated
- cheaper to install than its wired counterparts!



In-field sensing stations monitor soil moisture and soil and air temperatures. A weather station mounted on the irrigation cart monitors weather conditions in the field. All in-field data is sent wirelessly to the base station, which processes the information and determines whether and how much to irrigate based on the precise location (determined by differential GPS) of the irrigation cart in the field. The base station communicates back and forth with the mobile irrigation cart and the grower, who has ultimate control over what the station does.

JAMES KIM (D817-1)

Worldwide, irrigation is the largest single consumer of fresh water, using up to 60 percent of this precious resource, according to estimates by the U.S. Geological Survey. Most of this consumption occurs on farms growing food, feed, fiber, and fuel crops.

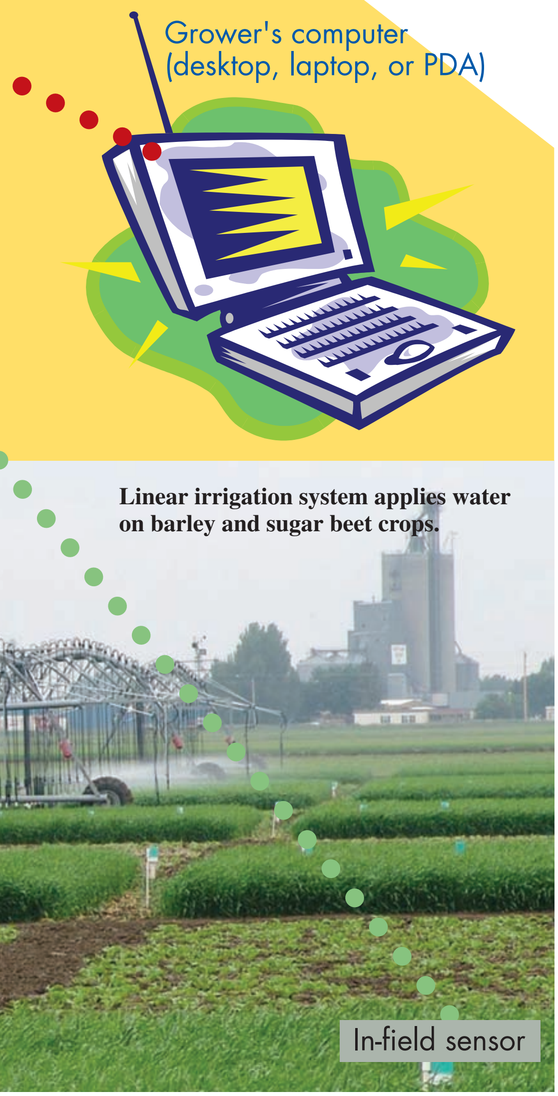
"In the United States, there are about 62 million acres of irrigated agricultural land," says Evans, "though considerable irrigation water is also used to maintain lawns, parks, and recreational areas."

It's worthy to note that in the United States, 60 percent of the market value of agricultural production occurs on irrigated lands—which represent only about 18 percent of the total cropland in cultivation. That's according to Mark Walbridge, who co-leads ARS national programs for soil and water resource management.

Knowing where the dwindling water resources are going is important, says Evans, so we can identify opportunities for saving water and energy and for reducing pollution caused by leaching of excess nitrogen and phosphorus.

At the annual meeting of the American Association for the Advancement of Science, held in San Francisco in February 2007, Evans and fellow ARS agricultural engineer E. John Sadler shared their latest research findings and personal convictions regarding the need for greater irrigation efficiencies. Sadler is based at the agency's Columbia, Missouri, location.

"Water is really going to be the prevailing natural-resource issue of the 21st century," says Evans, "especially when you factor in global climate change and the push to grow energy crops."



Linear irrigation system applies water on barley and sugar beet crops.

Going High-Tech

So what's the first step in establishing a state-of-the-art irrigation system that can save precious resources? Making detailed soil maps of a field. "This reveals the variability across the soil and enables us to determine how many sensors are needed to best represent a tract of farmland," says James Kim, a research associate at the Sidney lab.

Kim is responsible for designing and integrating the wireless components of the high-tech irrigation system. He says growers benefit from wireless communications in much the same way that other users of the technology do—by gaining freedom and mobility.

"Field conditions are likely to change over time," says Kim, "so the sensors assigned to various sections of farmland will need to be moved. It's more costly and problematic to move cords buried underground. With our system, there are no cords."

Instead, the field sensors use wireless technology to stream data to a main computer, which then transmits information wirelessly to the irrigation hardware itself.

Getting all of the system's complex components to "talk" fluently with each other was Kim's greatest challenge. These parts include field sensors, a weather station, and variable-rate irrigation hardware for doling out precise amounts of water and fertilizer.

Special software designed by Kim integrates the components seamlessly. Every 10 seconds, the field sensors measure soil moisture, soil temperature, and air temperature. This data is then transmitted to the base station every 15 minutes.

Evans and Kim are still evaluating the full extent of the system's resource savings, but both expect it will be especially effective at conserving fertilizer and reducing its pollution potential. "There should be a significant reduction in the tendency for surplus agrochemicals to leach into groundwater and other water supplies," says Evans.

If irrigated farming is to be sustainable into the future, it will depend on the kind of innovation being crafted by scientists at ARS. It will also depend on a shift in farmers' perspective.

"Before, we were focused on how much productivity we could extract from a unit of land," says Evans. "Now it's time to start thinking about how much we can wring from each unit of water consumed during the production process."—By **Erin Peabody,** ARS.

This research is part of Agricultural System Competitiveness and Sustainability, an ARS national program (#216) described on the World Wide Web at www.nps.ars.usda.gov.

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