Sandia Method Conserves Huge Quantities of Ag Water

from Sandia National Laboratories

A method that uses roughly one-hundredth the fresh water customarily needed to grow forage for livestock could free up massive amounts of water for human consumption and for residential and industrial uses.

The success of the method is being monitored by 42 wireless sensors being installed in a forage-growing hydroponic greenhouse built within a stone's throw of the Mexico border, under the supervision of Sandia National Laboratories, a U.S. national security lab.

Sandia is interested, says lab researcher Ron Pate, because "disputes over water are possible, if not likely, causes for war in the 21st century."

The potential savings in water is particularly important in New Mexico and the American Southwest, Mexico, water-parched regions like the Middle East, certain lands between India and Pakistan, and even northern China, where underground water supplies used intensively for agriculture are dropping lower, says Pate. "In all these places, the majority of water use is for irrigated agriculture rather than direct human consumption and other productive uses."

Preliminary indications are that hydroponic greenhouses could reduce the amount of land required to produce New Mexico's alfalfa from 260,000 acres to less than 1,000 acres, and reduce the 800,000 acre-feet of water currently needed to produce livestock forage to 11,000 acre-feet. Eighty percent of New Mexico's water use is agricultural, with over half used to grow forage, mostly alfalfa.

Conventional farming methods in arid regions lose huge amounts of water through evaporation and over-absorption by soil. Over time, this can also result in soil salination and loss of agricultural productivity. Neither are factors in hydroponic greenhouses, which do not require high-quality arable land to function.

Hydroponic greenhouses recently built in Chihuahua, Mexico, have been used by ranchers during the current drought to grow feed for their herds. However, technical questions about the amount of water saved, the nutritional value of the forage, and optimum light for best growth, have yet to be determined.

Thus, Mexican researchers take a keen interest in the U.S. project taking place just north of the border in Santa Teresa, New Mexico, near El Paso. Researcher Hector Gallegos and hydroponic forage system fabricator Francisco Aguirre are helping in the design, construction, and implementation of the project.

"The difference [between our projects and this one] is the sensors Sandia is installing to check things there," Gallegos said. "Normally we only use a humidity sensor to know when to run our irrigation."

The Sandia-placed sensors and computer simulations will tell researchers how to grow crops still more efficiently, Gallegos said. His tests used only readily available wheat and corn; the Sandia tests also include triticale, sorghum, barley, and oats.

The nutritional quality of the hydroponically grown plants will be determined by Clint Loest, a professor of animal nutrition at New Mexico State University.

"If we can get the animals to perform just as well on greenhouse forage, that would be an incredible advance. ... We might even give up a little performance if it's going to save so much water," he said.

The difference between traditional agriculture and hydroponics is that the greenhouse plants do not draw nourishment from the earth. In this experiment, they rely on the nutrition present in seed that is germinated, precisely watered, and harvested after about 10 days of growth. Thus, more seed is required for the production of an equivalent amount of forage (compared to that traditionally grown in open fields), but with far less water use.

The hydroponic greenhouse also controls and modifies light reaching the plants. Experiments will reduce light intensity and restrict certain frequencies, using a variety of shading mechanisms to avoid overheating and improve plant growth.

How It Works

The dense array of sensors in the 8m by 18m (26 ft by 59 ft) greenhouse will monitor light, temperature, relative

Continued next page

humidity, and air pressure. The data, collected every few minutes, will be sent by phone line to a remote computer for analysis. "We expect that the [greenhouse] system will not be as slow-moving or spatially homogeneous as one might think in terms of environmental change," Pate says. "Every time the water system pops on, the local temperature around the plants drops relatively quickly."

"We want to be aware of microclimate variances," says Pate. "We want to know how feed grows from changes in temperature and location and time of watering. That will help us modify the design and operation of the greenhouses."

Whenever a humidity sensor or a back-up timer trips a control circuit, water sprays from quarter-inch nozzles for 20 seconds into plants growing in a series of plastic trays stacked on metal racks. To lessen labor and also protect against mold, researchers are exploring the development and use of trays that themselves would be edible by livestock, thus making washing and sanitizing trays unnecessary. Such tray material could also add nutrition content to the overall forage product, making it a more balanced ration for the livestock. Consumption of water, seed, and labor also are being monitored.

Visit www.sandia.gov.

Water Scarcity Threatens Global Business

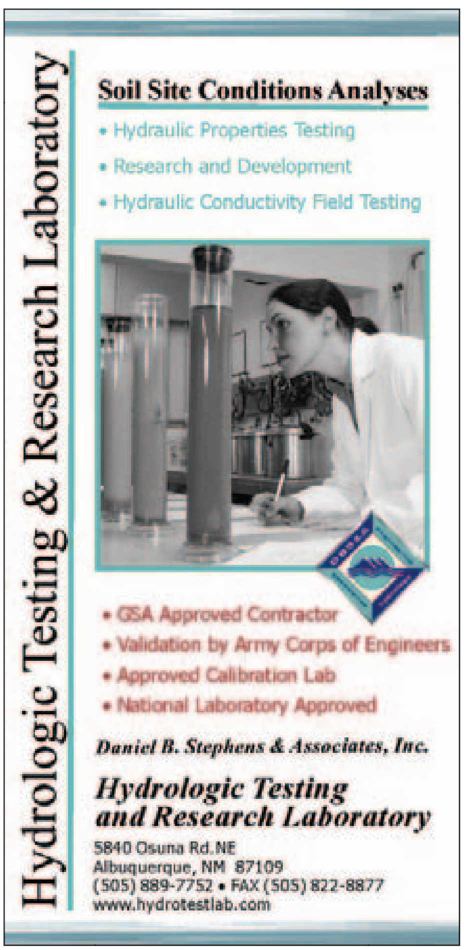
from the Pacific Institute

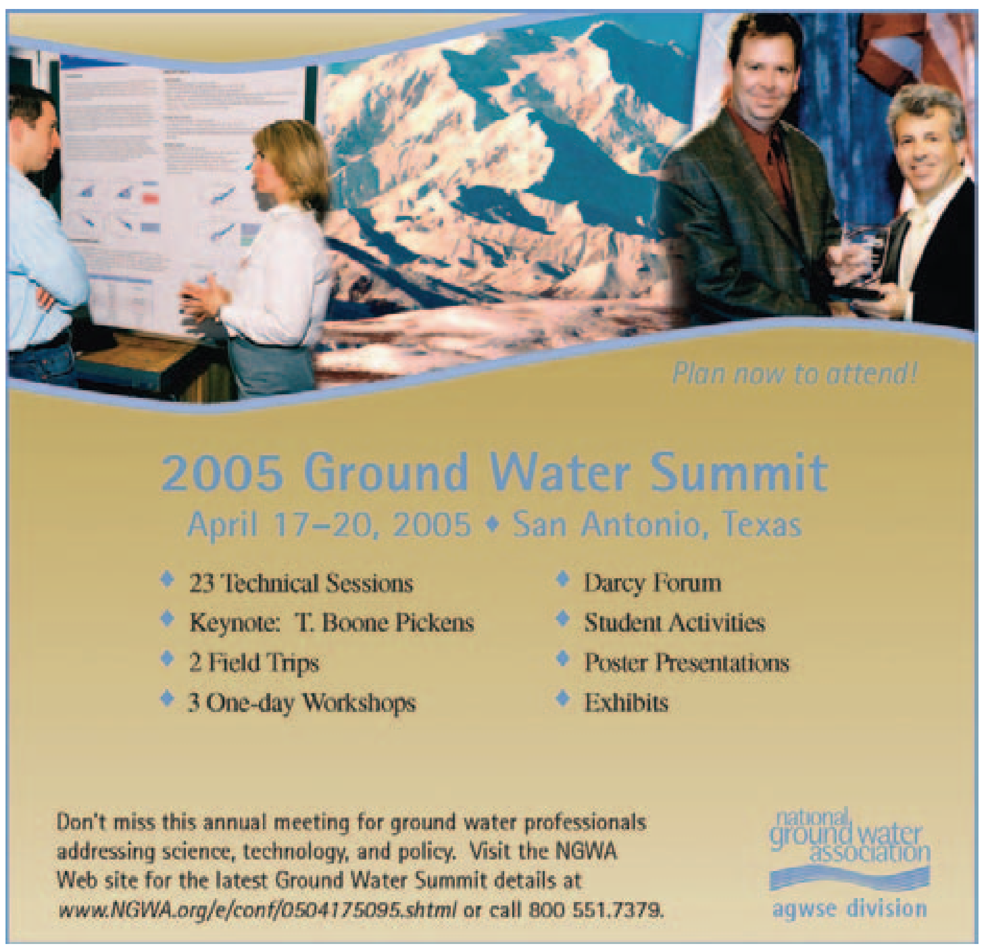
Businesses around the world, from beverage companies to chip manufacturers, are failing to prepare for the serious economic and political risks posed by growing competition for fresh water, the threat of water contamination, and rising water-related costs. These risks can lead to plant closures, supply-chain disruptions, and public opposition to local business activities.

That's the message of a new research paper by the Pacific Institute, a nonpartisan research group based in Oakland, California. The report identifies a range of worrisome trends that impact businesses in almost every sector, and recommends steps that companies can take to meet these challenges head-on.

The study, "Freshwater Resources: Managing the Risks Facing the Private Sector," outlines a range of problematic trends: growing water scarcity in the face of skyrocketing demand and increasing competition; community concerns about industrial water use and pollution; and potential changes in water availability and quality stemming from climate change. Severe water shortages can lead to supply chain interruptions, poor product quality, and even loss of license to operate. Already, local governments have forced some multinational companies to close major factories due to concerns about the impacts of their water use.

The report recommends ten steps companies can take to reduce their water-related impacts on the environment and





local communities, and help protect their operations and their shareholders from business risks related to water. These steps include measuring their current water use; establishing a water policy with specific goals and performance targets; improving w ater efficiency and conservation efforts; and engaging suppliers, community groups, and outside partners in an open dialogue on the issue.

Visit www.pacinst.org.

Reduced Snowfall Linked to Air Pollution

from the Desert Research Institute

A three-year study by Desert Research Institute (DRI) scientists Randy Borys and Doug Lowenthal, in collaboration with the National Center for Atmospheric Research, indicates that polluted air can reduce winter snowpack contributed during individual storms by 50 percent. Their research is zeroing in on the long-term reduction in annual snowpack, which could be as much as 25 percent.

This is especially bad news for drought-ravaged western states, such as Colorado, Nevada, Arizona, and New Mexico, that depend on runoff from snowpack to fill their streams, rivers, and lakes, and recharge the groundwater.

"In normal years, you might not notice a decrease in the water content of snow, but after five years of drought, every drop counts," Borys said. Even though pollution does not create droughts—which are caused by larger atmospheric and climatic conditions—dirty air could be making the situation worse.

Tiny (0.1–1 micrometers in diameter) naturally occurring and pollutant-formed aerosol particles, known as cloud condensation nuclei, form microscopic cloud droplets, and these droplets typically form ice crystals or combine with other crystals to form snowflakes. The work of Borys, Lowenthal, and others has shown that when aerosol particles from air pollution increase the number of cloud condensation nuclei, the number of droplets also increases, but the average diameter of cloud droplets is reduced. This process ties up more of the available moisture in the cloud, and the smaller, more numerous droplets essentially disperse and evaporate before accumulating into droplets large enough to fall to the ground.

Sulfate, nitrate, and possibly some organic compounds in the form of tiny atmospheric particles are the culprits. These particles are the byproducts of almost any combustion process, including natural fires. However, the persistent generation of pollution containing these minute aerosol particles, day in and day out, sets the stage for the process to occur.

The scientists have been conducting their research at DRI's Storm Peak Laboratory atop Mt. Werner in the Rockies, near Steamboat Springs, Colorado. The laboratory is at an elevation of 10,500 feet in an area that experiences the maximum snowfall for northwest Colorado.

Visit stormpeak.dri.edu.