From lasers to satellites, technology helps farmers conserve water and use it with the utmost efficiency.

Space Age Technology Down on the Farm

by Lorraine Kingdon

Running a profitable farm or ranch in Arizona has long since moved into high technology — sophisticated equipment with a "Star Wars" or "James Bond" touch.

From lasers to satellites, technology helps farmers conserve water and use it with the utmost efficiency. With new kinds of energy-efficient fencing, ranchers can run more cattle on less land and still do the land a favor, ecologically.

Using a laser beam to help level land is not new in Arizona; farmers started using this technology about eight years ago in Yuma. Nearly half the irrigated acreage, some 700,000 acres of farmland, are leveled this way now, says Dr. Harry Ayer, UA economic policy specialist.

Irrigation experts Walt Hinz and Allen Halderman describe laser leveling as a laser beam sent from a rotating command post; the beam is set at whatever level the field is to be graded. A receiver is mounted on a mast attached to a scraper; the laser signal keeps the scraper at the desired grade by operating hydraulic control valves automatically.

The laser signal operates so accurately that the land can be leveled to within plus or minus .05 of a foot — about half an inch. Farmers can simply smooth the slope of their existing furrow irrigation system or they can make their fields dead level at zero slope. Approximately 400,000 acres are lasered dead level in Arizona and 300,000

acres are lasered to slope.

Both leveling techniques save water by making irrigation more efficient — reducing runoff and preventing the water from percolating beyond the root zone. Ayer says farmers save on the cost of the water, plus they also may increase crop yields from 10 to 30 percent. However, he adds that laser leveling is not cheap, although it costs less than half as much as another water-saving technique, drip irrigation.

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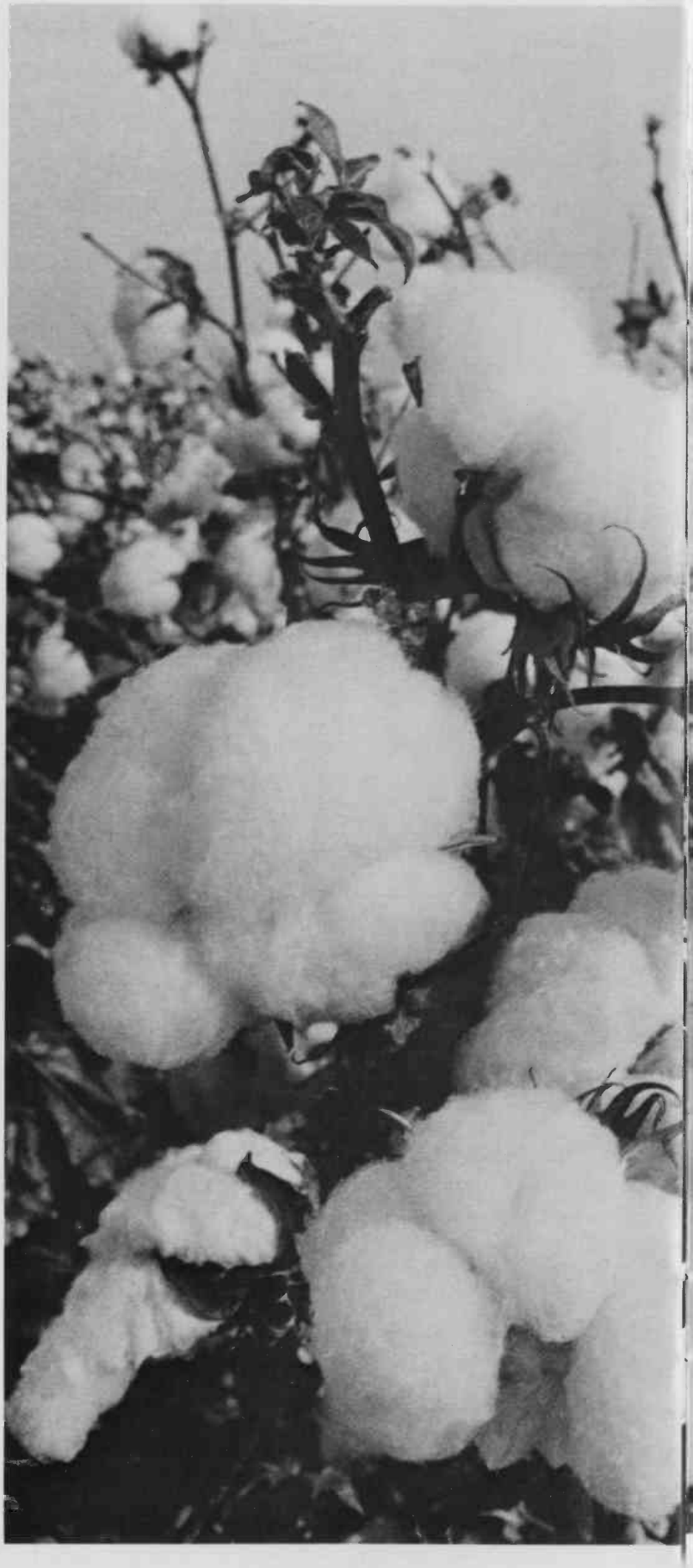
A working definition of drip irrigation is the precise, slow application of water in the form of drops, tiny streams or miniature sprays through mechanical devices at selected points along water delivery lines.

The idea is hardly new; Nebuchadnezzar used a drip system to irrigate the Hanging Gardens of Babylon. But modern drip irrigation dates from the mid-1960s when techniques were commercially developed in Israel. By 1984, Arizona growers were irrigating more than 20,000 acres using both aboveground and subsurface systems.

They do more than just put water through plastic pipes. For example, Arnie Schlittenhart, manager of Regal Farms, Eloy, can vary the level of water and fertilizer by simply making a change on the computer control. He also can control insects and weeds by putting pesticides and herbicides also may be delivered though the pipes.

It's not an exact science. Not yet. UA entomologists, weed specialists and plant and soil scientists are testing the response of cotton plants at Regal Farms. Dr. W.C. Hofmann, plant breeder, checked three different cotton varieties for their response to five different water levels; Dr. Jack Stroehlein, soil scientist, looked what happened with four different nitrogen fertilizer treatments. Entomologist Dr. Irene Terry checked the effectiveness of pesticides applied early in the season through the drip pipes. And weed specialist Stan Heathman is trying to fine-tune weed control.



(inset) The neutron probe is used to measure the water needs of cotton and other row crops.

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Scott Tollefson, manager of Sundance Farms, Coolidge, has had five years experience with subsurface drip. He says automation — high tech — is a big factor. "One man can irrigate 1,200 acres with our system. One rig will do all our tillage, for instance. We wanted to reduce the labor needed to grow a crop, but the water required and break the yield plateau of cotton. We've accomplished all three."

Water scarcity and water prices have more or less forced Arizona farmers into using a combination of high technology, automation and common sense to make sure they use as much water as their crops need. But, no more.

Neutron probes measure the water needs of 65 percent of the crops in the Wellton-Mohawk area of Yuma County, says Roger Koewers, Bureau of Reclamation irrigation specialist. Taking regular probe readings tells the grower how much moisture is being used out of the root zone in the soil.

Add a computer to do the calculations automatically and farmers can tell when to irrigate and how much water is needed to fill the soil to capacity. They also will know how many hours it will take to apply the needed water.

The probe measures hydrogen atoms in the soil; the fast neutrons the probe emits are slowed down when they collide with hydrogen and are then counted by the detector tube. The only hydrogen source is water; when the count is high, the moisture level is correspondingly high, and vice versa.

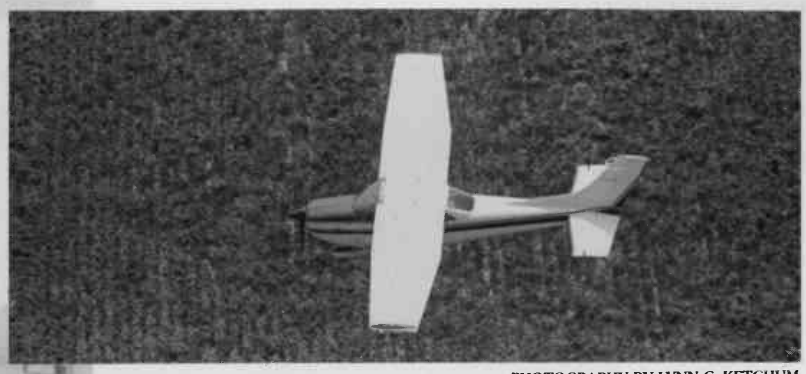
Information from the satellite may someday reveal the vitally important fact that could finally put an end to Texas root rot.

Knowing the soil water level helps a grower avoid wasting water in unnecessary applications. Fewer applications mean less labor required and fewer nutrients leached out of the soil. Some evidence shows an increase in crop yields, according to UA Extension County Agent Barry Tickes. In 1982 tests, 600 more pounds per acre of wheat were harvested from fields monitored with the probe than from fields not monitored.

HECTOR GONZALEZ

A palladium probe inserted into the plant's main stem constantly monitors the plant's condition. The information is sent to a computer buried in the field. The computer takes similar measurements from other plants in the area. The result a visible readout that tells the grower if the plants are stressed and need water. Eventually the information will be transmitted directly to the farmer's home or office.

(opposite page) Dave Ammon, UA pilot and technician, double checks aerial photo equipment before flying over research plots at the UA Maricopa Agricultural Center.



PHOTOGRAPHY BY LYNN G. KETCHUM

Measuring the moisture level in the soil is one way to tell when crops need water, but UA electrical engineer Dr. William Gensler has an even more direct method. Now a cotton farmer can watch his plants in the field just as closely as a human patient is monitored in a modern hospital.

Working with a U.S. Department of Agriculture grant award, Gensler has developed and successfully tested his solar-powered device. A palladium probe inserted into the plant's main stem directly measures the plant's condition and sends a message to a small computer buried in the field.

The computer takes similar measurements from other plants within an area about one-fifth the size of a football field. An easily visible readout at the edge of the field allows the grower to tell at a glance whether plants are stressed and need water. Next year, Gensler will test using a radio signal to transmit data from the probes in 20 to 30 fields at one time. Growers will even be able to get a hard copy printout.

It's quite a distance from buried computers to satellites flying high, yet both can detect when plants are stressed by lack of water.The neutron probe does it one spot at a time; the palladium probe does it one plant at a time; the satellite scanner detects stress for fields of plants in several counties at one pass.

Information from the satellite may someday reveal the vitally important fact that could finally put an end to Texas root rot, says Dr. Michael C. Parton, UA geographer. He believes that satellite imagery combined with an interactive computer system can eventually result in early warning maps showing where and when the disease will break out next. And, he thinks the imagery could lead to cost effective controls for a disease that has long been a puzzle.

The problem with data from the Landsat TM satellite is that it takes so long to get to researchers. Soon the UA Remote Sensing Center at the Office of Arid Lands Studies will update equipment with a multispectral video-imaging system that will be able to give detailed information about plants within hours. Perhaps someday farmers will be able to get the same service.

Every 16 days David Ammon, UA pilot and technician, flies over research plots at the UA Maricopa Agriculture Center to collect data to cor-

relate with the satellite pass. The new apparatus will consist of a video camera shuttered with a spinning wheel with six slots, each with a narrow-band filter for visible, near-infrared or polarized light, operating with a frozen frame of 1/250 second. The data can be analyzed in the analog form on the videotape monitor or put through a computer in digital form.

High-technology solar-powered electric fencing can effectively control high-spirited range cattle at a fraction of the cost of barbed wire.

"UA researchers hope to tell what is causing stress to plants — whether it's lack of water or fertilizer or insect or disease damage, Ammon says.

Modern ranchers in Arizona use fencing to help cattle avoid stress — to move them from pasture to pasture before the land becomes overgrazed and the cattle underfed. Four-strand barbed wire has been traditional, but it now costs between $3,000 and $4,000 per mile to install.

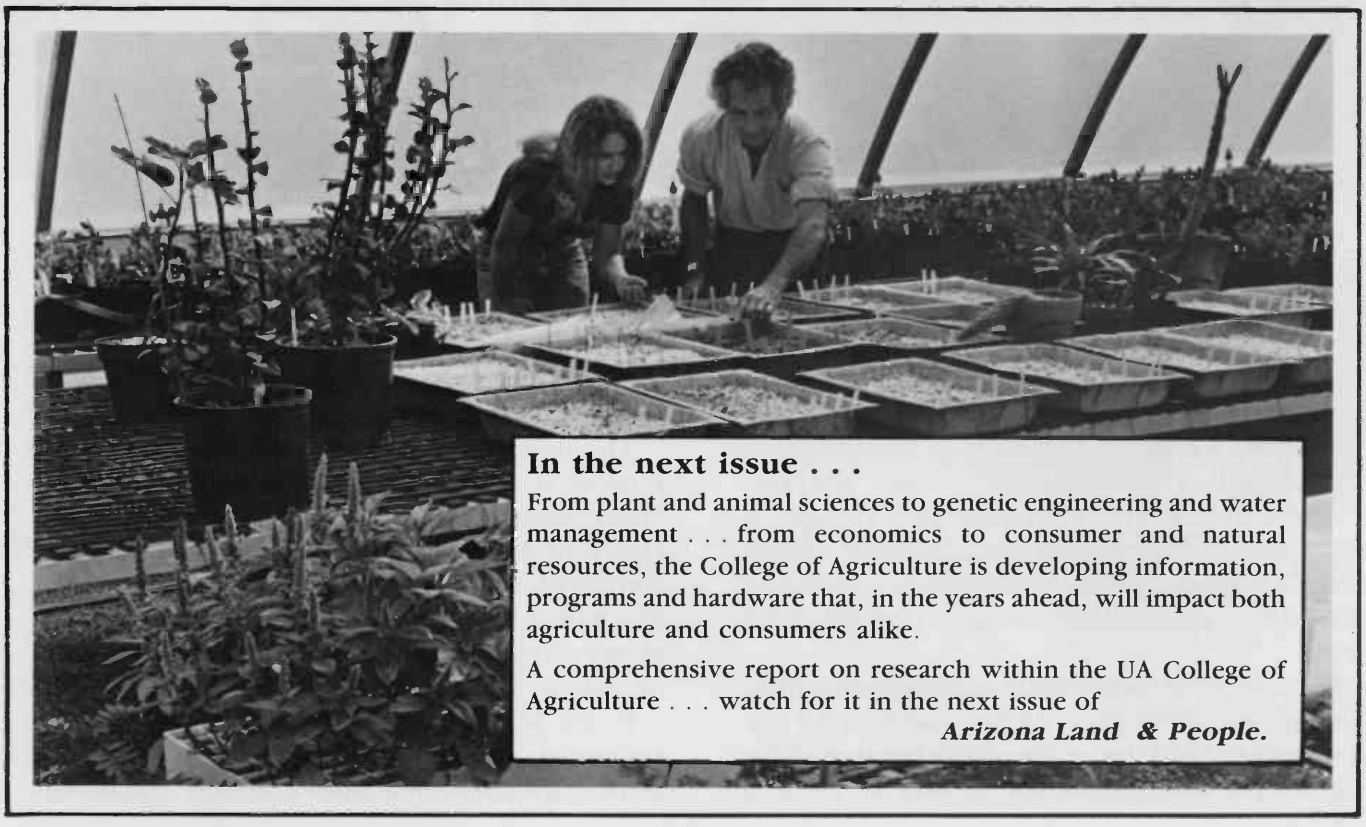
High-technology solar-powered electric fencing can effectively control high-spirited range cattle at a fraction of the cost of barbed wire. Brad Rein, UA Extension agricultural engineer, says the new fence can be installed at a cost of approximately $300 per mile.

Russ Cline, Wagon Bow Ranch manager, worked with Rob Grumbles, Mohave County Extension agent, to test the electric fencing — the first time a new combination of technologies was tested in the field.

Rein says a technological breakthrough in photovoltaic cells led to the potential savings. A small panel of the cells converts solar energy into electrical energy. Stored in a battery, the electricity is controlled by an energizer that emits short, periodic 5,000-volt electrical bursts into the wire. This power supply, readily available in remote areas, combines with new high-tensile wire and improved insulators to make the solar-powered fencing possible.

And, it works. Cline says, "The cattle learned to respect it in a short period of time. For the price, you can't beat it."

Being a successful farmer or rancher in Arizona has never been the easiest of occupations. Today, technology offers a helping hand.



In the next issue . . .

From plant and animal sciences to genetic engineering and water management . . . from economics to consumer and natural resources, the College of Agriculture is developing information, programs and hardware that, in the years ahead, will impact both agriculture and consumers alike.

A comprehensive report on research within the UA College of Agriculture . . . watch for it in the next issue of ***Arizona Land & People.***