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By Larry Reichenberger

EYES IN THE SKIES

Remote sensing technology is taking agriculture to new levels of efficiency

Technology is providing a bird's eye view that's helping farmers cut sky high production costs. That benefit is from remote sensing—a revitalized practice getting a boost from the expanded use of precision farming.

Two decades ago, remote sensing was hailed for its ability to detect developing disease and insect outbreaks and point to lurking nutrient deficiencies well before symptoms became visible in the field. This ability has carried the technology to widespread use in high-value crops and broad use in cotton, but adoption in other commodity crops has lagged.

To find new ways to gather and use remote sensing data, farmers, consultants and researchers are utilizing everything from ATVs to airplanes and satellites to spray booms. These platforms differ in their frequency, accuracy, and cost, but are similar in that they measure electromagnetic energy (light) that's reflected, absorbed, or transmitted by plant tissues.

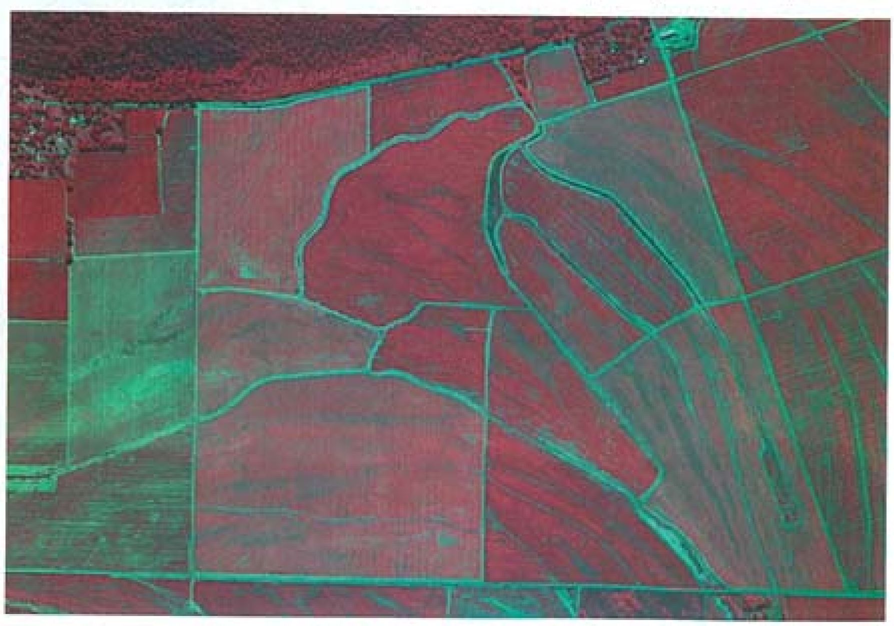
"We've found we can do a pretty good job of measuring the health of a crop by analyzing the light reflected from it," says John Solie, agricultural engineer at Oklahoma State University. "Green light is reflected by chlorophyll while red and blue light are absorbed. And, the reflection of unseen infrared light tells something about plant cell structure."

Seeing via satellite. Satellites have led the way in collecting remote sensing data, though frequency and resolution have limited some applications. Widely used Landsat data is available every 16 days at 30 meter (90 foot) resolution for about $1 per acre. Data from Quickbird and Spot satellites is more frequent with higher resolution, but also is more expensive. The impending launch of the five-satellite Rapid Eye network promises greater capability by offering 6 meter resolution and three-day repeatability.

"We're finding a real benefit to remote sensing by using the economical Landsat data to create management zones," says Luke Faleide, co-owner of Agri ImaGIS Technologies, Fargo, N.D. (*www.satshot.com*). "The images of a growing crop show vegetation zones which are used with soil maps, yield maps, elevation maps, and general knowledge of the field to create three to five management zones with similar properties. This information is used by producers to control variable-rate fertilizer applications."

Canadian agronomist Wade Barnes with Farmers Edge Precision Consult-

►**Below left:** Fields in this infrared aerial image will be divided into management zones according to plant health and maturity. ►**Below:** Oklahoma State University researchers use a crop canopy sensor to determine the nitrogen status of individual corn plants.



►**Above:** Crop canopy sensors designed to determine the nitrogen status of growing crops are being tested to map soil organic matter.

ing expects his company to use satellite remote sensing to help create management zones on 500,000 acres this season. "When we started in precision agriculture we were grid sampling, but that proved to be too costly. Now, we use remote sensing to create management zones that guide our soil sampling and allow us to develop a fertility plan. Generally, our growers are spending less on P and K and more on nitrogen, but they're increasing yields from 15% to 25%."

Barnes says remote sensing images are also being used to vary seeding rates and may serve a similar role with fungicides in wheat. "The remote sensing data we receive during the season tells us the amount of vegetation, or biomass. That information is an indication of disease pressure, so we hope to use it to vary the rate of fungicides," he says.

Focus on nitrogen. Aircraft-based remote sensing typically provides better timeliness and improved resolution—features that can streamline in-season use. North Bend, Neb. consultant Nick Emanuel with Pinnacle Ag Technologies is hoping that capability can help his clients improve nitrogen use efficiency in corn.

For the 2007 season, Emanuel worked with half a dozen Nebraska corn growers using a nitrogen management program. "Our approach was to let the crop tell us of its nitrogen needs by monitoring it with remote sensing, then adding nitrogen in-season with variable rate application," says Emanuel.

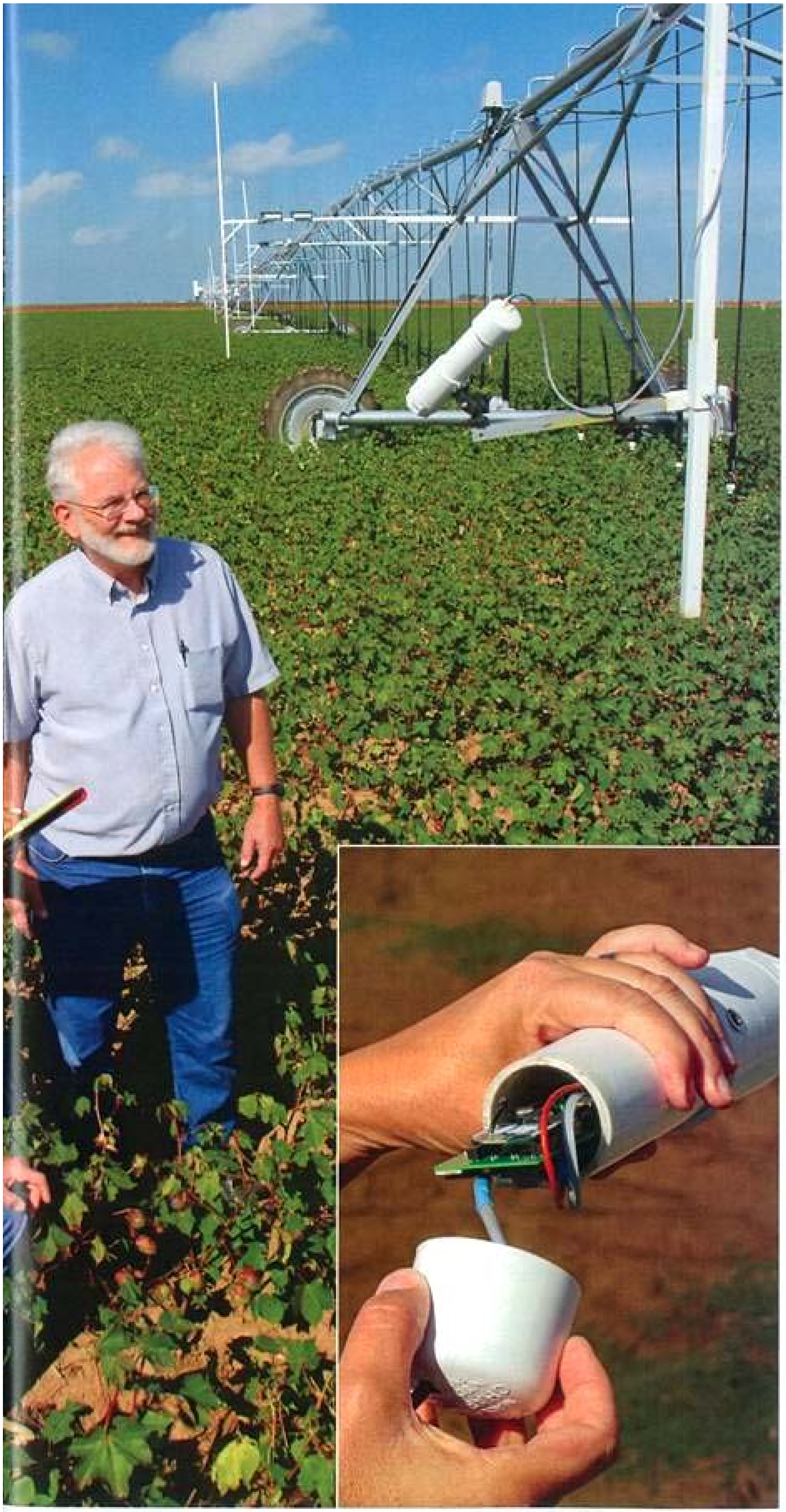
"We found changing a farmer's mindset was difficult—they really want to apply nitrogen in the fall or ahead of planting for timeliness reasons. However, there is a lot of interest in remote sensing as a way to check on the crop during the season to see if the nitrogen rate was correct, or spot developing problems," adds Emanuel.

Kevin Poppel, precision ag specialist with Triangle Ag Consulting, Ulen, Minn., says high resolution (3-foot) remote sensing data is helping his clients maximize nitrogen savings. "We use the data to develop three to five management zones for P and K application, but for nitrogen we might vary application rates to match 50 or more management zones," he says.

Poppel adds that other opportunities for remote sensing include combating iron chlorosis problems by tailoring soybean varieties to specific areas. "We can use a map of the NIR (near infrared) image of the field taken during the growing season to identify areas suffering from iron chlorosis. The next season, we use variable seeding equipment to plant a higher population or perhaps even substitute a resistant variety in those areas," he says.

Advances in remote sensing are also taking place at ground level, where many problems with scheduling and resolution disappear. For example, researchers at Oklahoma State have demonstrated the ultimate in remote sensing and control by using a GreenSeeker crop canopy sensor to determine the nitrogen needs of individual corn plants—then making the required application—all in a single pass.

"In a study done in seven states, we found that the plant-to-plant variability in corn averaged 40 bushels per acre. That means the nitrogen require-



ments of those side-by-side plants varied 50 pounds per acre. On-board remote sensing is the only way to identify that variability and respond to it," says OSU agronomist Bill Raun.

At the University of Nebraska, where the Crop Circle canopy sensor is being evaluated, researchers are using it to measure more than nitrogen needs. "We're mapping the organic matter level in soils by mounting the sensor on a planter, or running it over the field right behind the planter. This overcomes the interference crop residue causes with aerial image sensing," says soil scientist Richard Ferguson.

Automated irrigation. Another example of the potential of on-board remote sensing is an automated irrigation system under development at the USDA-ARS Soil and Water Management Research Unit at Bushland, Texas. There, soil scientist Steve Evett and his ag engineering associates are using infrared thermometers along the length of a center-pivot to sense crop leaf temperatures, determining water stress and scheduling irrigation.

"Irrigation scheduling is a complicated chore that few farmers undertake," says Evett. "As a result, irrigation water is often over applied, which can also result in crop nutrients being leached away. This system reduces the 'hassle factor' involved in irrigation management."

Evett explains that the sensors record average canopy temperatures for one minute intervals. This data is sent by wireless radio to a computer also mounted on the pivot. Programming in that computer interpolates data for all parts of the field using a temperature-time threshold method to decide when to turn on the pump and pivot.

"Our tests show this automatic method is as good or better than traditional irrigation scheduling techniques," says Evett. ■

►**Left:** USDA-ARS researchers Steve Evett (right) and Paul Colaizzi (left) work with Susan O'Shaughnessy to develop an automatic irrigation system. ►**Left Inset:** The unit's sensor is a PVC pipe packed with technology, including an infrared thermometer and wireless radio link.