



Remote Sensing Tools Can Add Precision to Your Farming Operation

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Precision agriculture, or precision farming as it is sometimes called, is a management strategy that employs detailed, site-specific information to precisely manage production inputs. Precision agriculture requires information about soil properties, landscape, elevation, and how these characteristics affect plant growth and crop progress throughout the field each season. Yield monitors provide a method to determine crop production in one part of the field, compared with another part.

However, by harvest time any opportunity to manage the crop is gone. Timely, inexpensive and accurate information is therefore important for the success of precision agriculture on individual farms.

Remote sensing is a method of collecting information about a field from a distance. There are many different types of sensors being used in agriculture. The most common sensors measure light reflected from the field. Of these, the easiest to use is a camera with color, or color-infrared, film. Color film provides information based on light reflected from the blue, green, and red spectrum. Color infrared film, when used with a yellow lens filter on the camera, provides a picture based on the green, red, and near-infrared spectrum.

Plants reflect light more strongly in the infrared spectrum than in the blue, green, or red spectrum. If we could see in the near-infrared (NIR) spectrum, we could more accurately assess the health of our plants. Because we cannot see light in the NIR spectrum, we can use sensors to improve our understanding of crop health.

We can also use digital cameras/photography to assess plant health.

The Dycam camera (www.dycam.com/adc.html), for example, provides information about the red and near-infrared (NIR) spectrum. Its digital images can be loaded into a computer for viewing. This is more efficient than using infrared film, which produces specially developed color slides (the developer does not use infrared lights in the processing) which are scanned and loaded into a computer for viewing. But scanning errors can sometimes change the intensity of colors on these images.

There are also more expensive and complicated



From left: Pilot, technician and Extension specialist work out a flight plan for aerial photography (remote sensing).

sensors which can provide information on crop health. Sensors which can see and record two to seven bands of light are referred to as multi-spectral sensors.

Multi-spectral satellite images are also now available for commercial use. The Ikonos satellite, for example, can record four bands of light (blue, green, red, and near infrared) at four-meter resolution (www.spaceimaging.com/newsroom/releases/2002/stereo.html). Another satellite, QuickBird2, can record multi-spectral images at even higher resolution (www.digitalglobe.com).

However, the most inexpensive method of remote sensing is to shoot infrared images with a 35mm camera (contact Kodak for a store that sells the film) through a photo port in an airplane while it flies over your fields.

Most of our research uses aerial photography to capture infrared images of cotton from altitudes of 3,500 to 5,000 feet above ground level. While there is still much to learn about remote sensing and what types of plant stress it can help us detect, we have a good understanding of some aspects of its usefulness.

These include:

1.) Differences in soil properties: Images taken in late June or early July indicate where soil properties are significantly different in a field. Images taken after the crop canopy covers the soil do not show soil properties as effectively as June or July images. This is because soil reflects red spectrum light more strongly than plants.

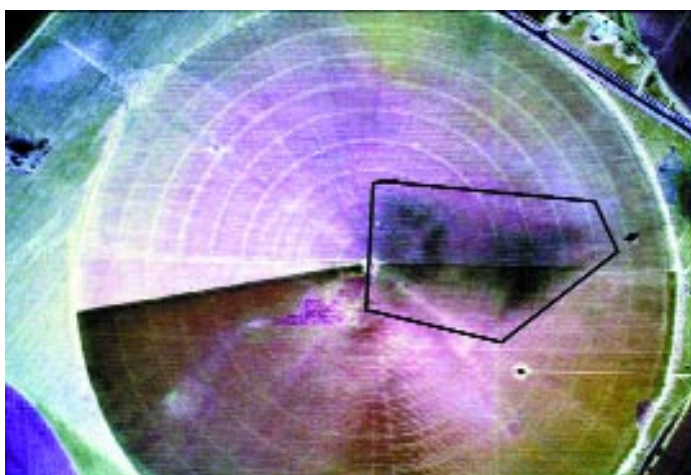


Image 1

A.) In this photograph (Image 1) taken in Terry county on July 10, 1998, the darker area near the center of the field has a sand content of about 50 percent and silt content of 40 percent. The lighter colored regions in the north and west of the center have 80 to 85 percent sand content and 6 to 13 percent silt content. The north side of the circle was in cotton and the south side was in peanuts. Plant height and yield were measured on part of the circle during the growing season. The cotton in the heavier textured area was stunted and yielded poorly, compared with the rest of the circle, which has higher sand content.

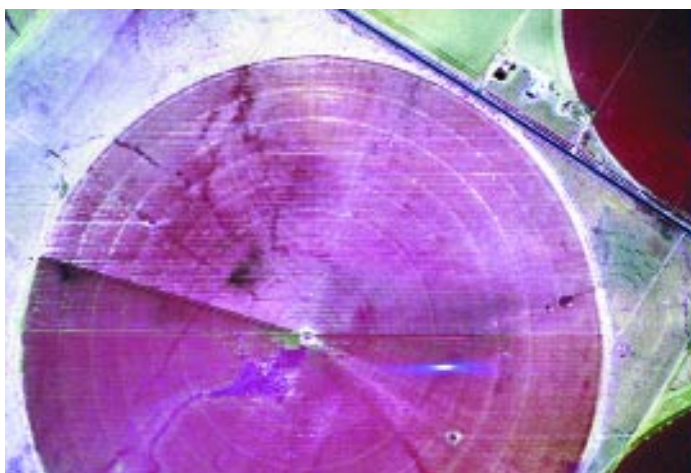


Image 2

In this later season photograph (Image 2) taken on August 25, 1998, soil texture differences are much harder to detect. However, erosion caused by water running down the slope is detectable. The same field was examined in 1997. In that year of plentiful rainfall, the silty center of the field had tall, rank cotton which should have received more of a plant growth regulator than the rest of the circle.

In this circle, we have found that soil texture and the slope of the field have a great impact every year on plant growth and crop yield.

Soil texture can affect the rate at which the producer applies: herbicide; Temik 15G (this field has root-knot nematode only in the sandier areas); amount of irrigation water; plant growth regulator; and fertilizer.

B.) The field shown below in Image 3 has two soil series present. The east side contains an Amarillo sandy loam and sandy clay loam which averages about 60 percent sand, 10 percent silt, and 30 percent clay. The west side contains a Portales sandy clay and sandy clay loam which averages about 48 percent sand, 15 percent silt, and 37 percent clay.

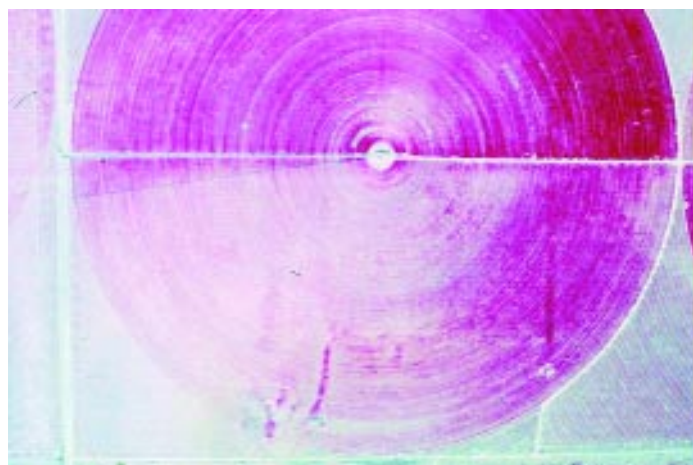


Image 3

The biggest difference, however, is the high levels of calcium in the Portales soil. The chalky color on the west side of this field is primarily due to caliche; which is a function of soil calcium levels. While it is never easy to predict which side of a field will produce higher yields, the crop often grows quite differently in these two soils.

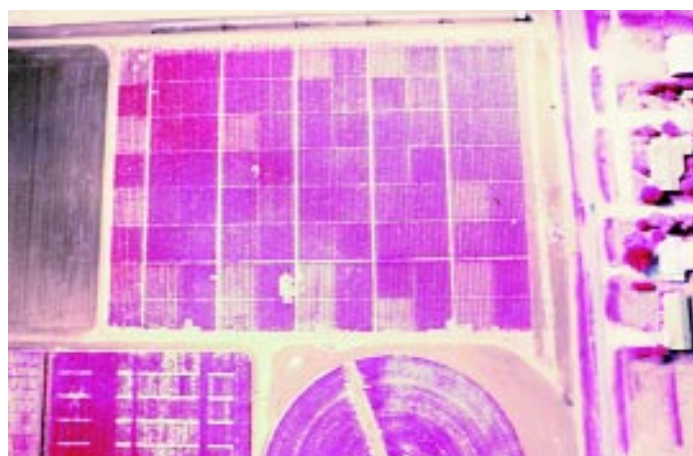


Image 4

2.) **Water:** Infrared images, such as Image 4, can also tell us which areas in a field receive more water, or where/how the water moves in the field.

The irrigation research field shown in Image 4 was photographed on Sept. 16, 1998, in Halfway, Texas. Each research plot has either a different irrigation rate or frequency of irrigation. The effect on plant growth is evident.

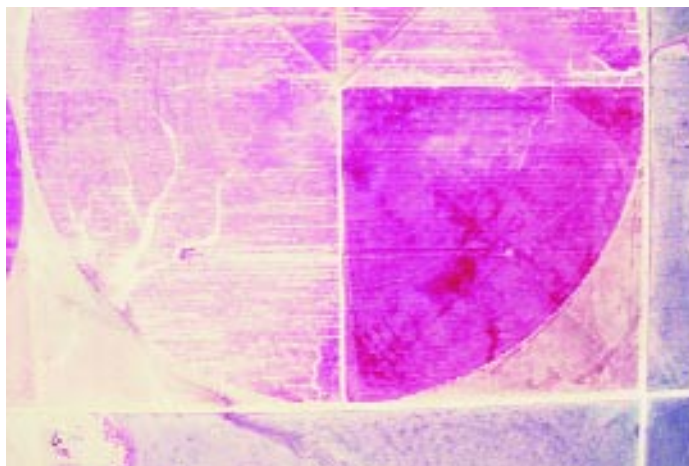


Image 5

Image 5, taken on August 11, 1998, shows a one-half mile long center pivot irrigation system. This producer planted the southeast quarter of this field to peanuts (bright red area), and the other three-quarters of the field to cotton.

The southwest quarter of this field (lower left) is sloped and suffers from a severe water erosion problem, shown by the irregular white lines extending upward from the bottom rim of the circle.

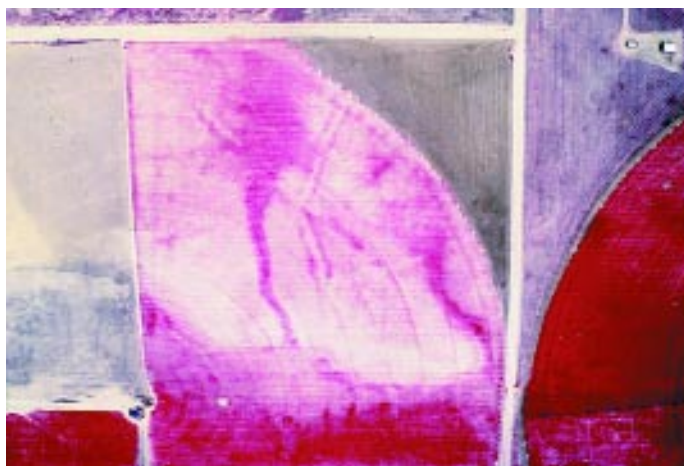


Image 6

Image 6, taken in September, 1999, shows the water movement pattern (darker areas in the northeast quadrant) in an irrigated circle, caused by a low spot. Yields are much higher in this area than in drier areas of the field.

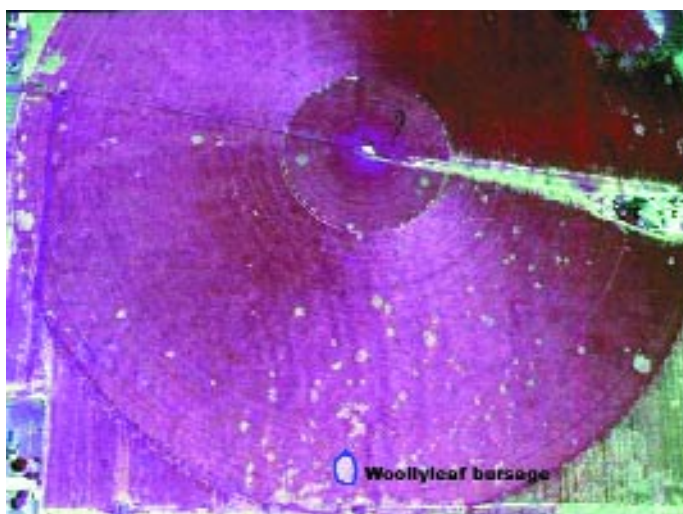


Image 7

3.) Weed Control: Weeds are not always randomly distributed across a field, but are often found in patches. We can use weed maps to observe these patches and note how they change over time. Image 7, for example, was scanned into a computer and geographical information system (GIS) software was used to determine the area of the field severely infested with weeds. In some cases, we can use infrared images to assess improvements from weed control programs.

This information could be invaluable when a producer is trying to decide how much to spend on weed control.

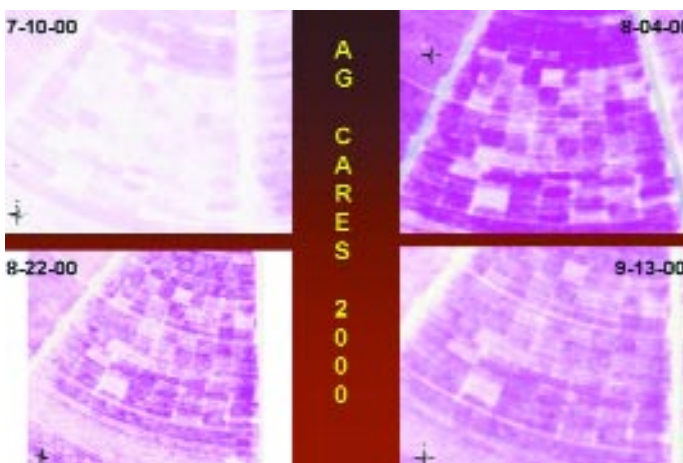


Image 8

Infrared photographs have also been used to detect peanut injury observed in the field, as shown in Image 8.

In this case, several images were taken of the same field at different times during the growing season. A lack of peanut growth, as a result of an early-season herbicide application, was obvious in these images.

Light-Activated Sprayers: Another Form of Remote Sensing

The use of light-activated weed sprayers is one way producers can utilize precision agriculture in their farming operations today. Sensors on these sprayers can tell the difference between light reflected from plants and light reflected from bare soil. Light reflected from weeds triggers the sprayer to apply a pulse of herbicide.

We conducted two years (2000-2001) of a three-year experiment near New Deal, Texas, to compare weed control in Roundup Ready cotton using the following treatments:

1) pre-emergence herbicides plus mechanical cultivation,
2) A. Roundup applied conventionally (broadcast at the four-leaf cotton stage followed by an application using a conventional hooded sprayer (BC/HS),

B. Roundup applied broadcast followed by an application using a light activated hooded sprayer (BC/LAS), and

C. Roundup applied using the light activated hooded sprayer only (LAS/LAS).

We calculated the percent herbicide savings, based on the amount of solution required to make a broadcast application followed by a hooded application.

Control of pigweed (Palmer amaranth) ranged from 64 to 76 percent for all early season treatments. At the mid- and late-season observation, Roundup applied BC/LAS provided at least 91 percent control. Late-season pigweed control from the BC/HS treatment was similar (95 percent), and was greater than the control observed following the LAS/LAS treatment (80 percent).

Effective control of common cocklebur and silverleaf nightshade (whiteweed) was also observed using the light activated weed sprayer. The BC/HS and BC/LAS provided similar and more effective control than the LAS/LAS and cultivation treatments.

The June Roundup application achieved a savings of 74 percent using the LAS. Roundup savings of 63 percent and 84 percent were observed with the July 3 application. No additional applications were made in 2001.

Lint yields ranged from 847 pounds to 936 pounds per acre for the BC/HS, BC/LAS, and LAS/LAS treatments, while the pre-emergence followed by cultivation treatment yielded 510 pounds per acre. Although not statistically different,



Cables Connections 1
LED Light Source 2
Optical Detector 3

greater yields were noted in areas receiving the more effective weed control treatments.

Similar to 2000, additional studies were established in 2001 on a producer's field near Ropesville, Texas. In 2000, the LAS was used to control pigweed and devil's-claw in Roundup Ready cotton in a minimum tillage system following a BC application of Roundup. Plot size was 15 acres. Control of pigweed and devil's-claw was 95 and 80 percent, respectively, and herbicide savings ranged from 70 to 78 percent. Unfortunately, the 2001 study near Ropesville was lost to hail and was not replanted to cotton.

Additional work in 2001 involved weed mapping fields during herbicide application. Weed maps will be used to observe how weedy patches change over time. Studies in 2002 will attempt to illustrate how weed distribution changes over the course of the season.

These studies conducted during the past two years indicate weed control programs utilizing the LAS may provide weed control similar to a conventional sprayer, with a significant herbicide savings. Results in 2000 were more favorable than results obtained in 2001.

Studies in 2002 will conclude our analysis of the light-activated weed sprayer.

We will also examine the cost of the light-activated sprayer in detail at the conclusion of our experiments.

Notes:**

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