Basics of Remote Sensing and Applications for CCA Work

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Abstract

Remotely sensed data may enhance your abilities to focus on problem areas within a field. It can also assist you in predetermining (by the patterns shown on remote sensed images) as to whether one is dealing with a nutrient, pest, and soil condition or management problems. It doesn't alleviate one from going to the field. In fact, ground reference data is your most valuable friend when using remotely sensed data. This presentation will cover types of available remote sensing data, types of image displays, and ground referencing (sometimes called ground truth) that assists one in analyzing or interpreting the data/images and ways that you can use remote sensing in your Certified Crop Advisor (CCA) work.

Introduction

Since the development of remote sensing nearly 60 years ago, there have been many reported agricultural applications. Some have proven effective while others have not succeeded, especially in assisting farmers with problem solving. The main cause for lack of effective applications has been the lack of technical assistance from professionals, such as Certified Crop Advisors, who are in frequent contact with farmers. Profit margins for individual farmers are forecasted to be slim for this harvest season; therefore, farmers are likely to take seriously any technological advances that will help increase those margins. So far, the use of remote sensing has been perceived as cost-effective for the high value crops, where the financial risks per acre are greater. Remote sensing has not been perceived as cost-effective for Midwest crops where weather is the greatest variable and therefore not manageable. Recent advances in the spatial, spectral, and temporal resolution of remote sensing (Johannsen, 2008), as well as potential positive changes in cost and availability make it a profitable tool for more farmers (Johannsen et al., 2005). There are some practical applications of remote sensing that are often overlooked by many farmers and advisors. Some of these applications will be highlighted in this paper.

The space age has now reached agriculture. Within the next 10 years there could be more than 20 new land-viewing satellites. And major changes are occurring in remote sensing technology, impacting agriculture in several significant ways—more data and variety of data available; more timely information; and more cost-efficient access to data. For agricultural decision-makers, this means that remote sensing can provide much greater detail of the land surface, repeat data, and the ability to merge data sets such as yield maps, soil maps, scouting data, and similar data that has geographic coordinates.

A major fear for all of us is that the remote sensing technology might be over-sold. This happened in the 1970s when people were told that they would be able to detect diseases, nitrogen deficiencies, and many other stresses—all of which proved false or inconsistent. But the conditions for applying remote sensing to agricultural management are now greatly improved. The improvements have come through advances in sensor technology, as well as dramatic improvements in computer hardware and software, and the ability to rapidly transfer data between remote locations. We must realize, however, that we are dealing with complex technologies that require specialized training and patience for achieving success in real applications.

What is remote sensing?

A formal definition of remote sensing is “a measurement that you can make of an object without touching it.” We typically think of a digital camera as a form of remote sensing. However, when we put that camera or a sensor in an airplane or satellite and modify the wavelength of light energy through filters, we are measuring specific regions of reflected light that can tell us more about soils, plants, and water. Let’s look at what can be done with this new remote sensing technology. Using aircraft sensors to provide data, we have been able to map field boundaries, locate stressed vegetation, and detect unusual conditions within experimental sites and on farmers’ production fields. Remotely sensed data are also useful in helping to define management units. Areas with similar responses within a field can be identified and sampled together. Therefore, this directed sampling approach could replace typical grid sampling techniques that disregard soil variability.

Remote sensing technology has seen many changes since the 1990s. Because of improvements in sensors, computer chips, software, and services, agriculture has been seen as a potential application to reap benefits at ground and space altitudes. Farmers can either analyze this remotely sensed information themselves or rely on commercial companies or crop advisers to perform this service for them for a fee. Some farmers have already received the benefits of satellite remote sensing data. Satellite images from Landsat and SPOT, the U.S. and French satellites, respectively, have been used to distinguish locations affected by such problems as weeds, excessive moisture, low soil pH, and imbalance of plant nutrients. Satellites like the IKONOS, Quickbird and Orbview satellites have allowed farmers to obtain essentially an aerial image of their fields and have already shown information and management promise for intensive crops such as vegetables, orchards, and vineyards (Johannsen and Carter, 2001).

The cost and timeliness of obtaining the images has been the biggest deterrent to date to regular use of such remotely sensed data. Satellites launched during the last 10 years by Digital Globe, Space Imaging, Rapideye and others are competing for the agricultural market; however, there are not enough satellites available to provide images when one really needs them. These multispectral satellites provide images in three to six different wave-band frequencies plus black-and-white images at 0.6-4 meter resolutions.

The remote sensing part of crop scouting will need to prove itself in the grain crop areas with an eye on the profit margin of these crops when it is high, such as corn in recent years and soybeans during this past year. Remote sensing has been tested successfully on potato fields in many parts of the world, in part because of the higher crop value per acre as well as the more consistent profit margin. Commercial remote sensing companies have used weekly images to map the acreage of potatoes and monitor their conditions throughout the growing season. The images and interpretations provide growers with an improved bargaining position when contracting with food processors, since they will have a prediction of harvest dates and knowledge of how their competitor's potatoes are performing (Potato Association of America, 2009).

Applications important to Crop Scouting

Detection of stress is an important issue in agricultural management and the bottom line for producers. With remote sensing, we are in a position to interpret what is causing the stress without going to the field. Note that this is not measuring a specific stress, but interpreting what the measurements are showing. There is a difference! Identification of crop variability will lead to the recognition of population variation, differences in soil properties, and many other variables. Again, we can show the location of the variation and a visit to that area in the field by a trained crop advisor may be necessary to determine the cause.

Other remote sensing applications have received attention from the agricultural community. These include land-use mapping, soil erosion detection and assessment, wildlife habitat assessment, crop commodity compliance monitoring, and assessing weather-related crop damage (Moran et al., 1997). The use of geographic information systems (GIS) and global positioning systems (GPS) for improving the accuracy of identification, monitoring, and location will lead to many more applications. It will take an understanding of the technologies and their limitations to have successful applications. With this understanding, data collected by the GPS operations can be automatically used by the GIS program.

Ground Reference Information

Remotely sensed data can be analyzed and added to the GIS using soil maps, digital terrain, and field operations information as ground reference (formerly called ground truth). Through the years "ground truth" has meant many things depending on the method used to collect the data, the experience of the person collecting the data, the purpose for the collection of the remote sensing data, and the time interval between when the remote sensing data were collected and when the ground truth data were collected. As McCoy (2005) explained, ground truth has been replaced by "reference information" to be more inclusive than "ground" and less absolute than "truth." Therefore, the term "surface reference data" is intended to mean any data or information collected to support the analysis and interpretation of remote sensing data obtained for studying air, land, and water resources (Johannsen and Daughtry, 2009)

Surface reference data/information may be categorized as discrete or continuous. Discrete data are qualitative descriptions that would convey differences between regions within an image such as corn, soybeans, alfalfa, and other crops, but could contain specific labels such as variety names, row width, row direction and similar information. Continuous data are specific measurements such as physical or biological characteristics that a crop scout would collect within a specific crop field, such as leaf area index, soil moisture, soil organic matter content, insect damage, and leaf chlorophyll content with locations marked by GPS measurements (Figure 1). Thereby, one could overlay the data or observations collected on a soil map or yield map of a previous year to look for possible patterns that should be shared with the producer. Although all GPS coordinates contain errors, a crop scout can often mitigate common GPS errors resulting from multi-path reflections, electrical interference, poor satellite geometry, and obstructions (McCoy, 2005). For more information on GPS, numerous excellent texts (e.g., French 1999) and online tutorials (e.g., www.trimble.com/gps/; www8.garmin.com/aboutGPS/) are available.

The value of a farmer/crop adviser knowing his or her location within a field are: (1) the collection locations of soil samples and thereby, the laboratory results can be compared to a digitized soil map, (2) fertilizer and pesticides can be prescribed to fit soil properties (e.g. clay and organic matter content) and soil conditions (e.g. relief and drainage), (3) one can use lightbar technology for accurately applying and documenting the rates of pesticides, (4) observations of crop conditions during the growing season can be documented for revisits and (5) yield data can be monitored and recorded as one goes across the field. All of these applications involve more precision in the collection of data and information, which means that the farmer/crop adviser needs a system for keeping track of it for future decision-making (Johannsen and Daughtry, 2009).

References

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Figure 1. Students learning to use GPS, maps, and remotely sensed images on a notebook computer to locate and annotate conditions of crops.

Figure 2. An unmanned aerial vehicle (UAV) is taking-off from a grass runway. The UAV, developed by Intellitech Microsystems, can carry a variety of remote sensing instruments and can be programmed to acquire images over agricultural fields to assist crop scouting.