Understanding Remote Sensing Technology

Unit A. Mechanical Systems and Technology

Problem Area 8. Technology Systems

Lesson 7. Understanding Remote Sensing Technology

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: IX: Use the variety of tools available in computer systems to accomplish fast, accurate production in the workplace.

Benchmark: IX-A: Identify and explain various types of hardware systems to show their applications potential.

Performance Standard: 1. Identify and describe individual components of each system. 2. Discuss various types of diagnostic equipment. 3. Be able to show aptitude in use of various equipment. 4. Demonstrate competency on cable though put and set up.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain remote sensing.
2. Describe how remote sensing systems gather data on agronomic crops.
3. Explain how precision farming uses remote sensing.
List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:


Other Resources. The following resources will be useful to students and teachers:

www.aces.uiuc.edu/~vo-ag/precise.htm

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters

Terms. The following terms are presented in this lesson (shown in bold italics):

Active system
Aerial photography
Frequency of coverage
Geographic Information System
Ground-truthing
Passive system
Pixels
Remote sensing
Satellite imaging
Spatial resolution
Spectral resolution
Spectral response
Vegetative indices

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

It’s the middle of July, and it’s time to check the cornfields to see how this year’s crop looks.
There are two ways to do this:

Option #1—Go into the 100 degree heat and start walking through the 7 foot tall corn stalks. Of course the leaf edges will cut your face, arms, and neck, the bugs will buzz your eyes, the pollen will make you sneeze. Last night’s rain will cause your feet to weigh 10 times their normal amount because they are covered in mud, and you can really only see about 5 rows on each side of where you are walking.

Option #2—Sit down at your computer in your air-conditioned office and download the remote sensing imagery that indicates the exact locations that vary from the normal plant growth taking place in the rest of the field. Use diagnostic tools to determine why those areas are performing below their peak performance, and make a decision that may correct the problem.

How will you check your corn field?

### Summary of Content and Teaching Strategies

**Objective 1:** Explain remote sensing.

**Anticipated Problem:** What is remote sensing?

1. **Remote sensing** is a group of techniques used to collect information about an object or area without actually being in contact with that object or area. Remote sensing can be used in precision farming to gather data about an area in order to make management decisions. This can be accomplished through two processes:

   A. **Aerial photography** can be done with modern aircraft, using photography or electro-optical sensors. These take a “snapshot” of an area and information can be gathered based on the differences in color within the image. Aerial imagery can be done by private companies or by individuals.

   B. **Satellite imaging** uses satellites in space to gather information on an area. Though the distance is much greater than that of an airplane, satellite based sensing can provide very detailed information. Remote sensing through satellite imaging uses one of two systems— LANDSAT (Land Satellite), which is a group of governmental satellites used to collect environmental information about the earth’s surface, or SPOT (Systeme Pour l’Observation de la Terre), operated by the French government. Data is retrieved from these satellites by special request.

A variety of teaching methods can be used to help students master this material. Assigned readings in the recommended texts will help students in understanding the content. Have students consider using a video camera or still camera. The photos and images gathered with those cameras can be used to show the gathered information to people who were not at that place at that time. Remote sensing can provide precision farmers with information that they could not see from their viewpoint. See TM: A8–7A to reinforce the two methods used to gather remote sensing information.
Objective 2: Describe how remote sensing systems gather data on agronomic crops.

Anticipated Problem: How does remote sensing gather data on agronomic crops?

II. Remote sensing gathers information about an area by utilizing light waves within the electromagnetic spectrum. The weather maps that show cloud cover and precipitation use remote sensing to provide that information. When light waves travel through space and hit an object, the waves can reflect off the object, be absorbed by the object, or be transmitted through the object. Often, more than one of these reactions occur. In addition, all objects with a temperature above absolute zero emit radiation of their own, though this is not visible to the human eye. Every object causes a unique reflection of wavelengths, known as a spectral response. Remote sensing uses all of the reflected and emitted radiation to create a differential map that shows differences in an area. All areas that have plants that had a consistent growth and health would appear the same, while areas that had poor growth or a lack of vegetative material would appear different from the healthy plants.

A. Remote sensing systems can be an active system, such as a radar, that generates and detects its own signal, or a passive system, which detects signals that occur naturally.

B. Spatial resolution is the size of the object that can be distinguished through remote sensing. Some systems can distinguish each plant from the next, while other systems can only see each row distinguished from the others. Spectral resolution determines how well the system can distinguish between different wavelengths of energy. Frequency of coverage refers to how often the system is available to view the area to be remotely sensed. Some methods, such as airplanes could be used as often as a customer desires. Satellite methods may not be able to access the area in question as often as desired.

C. When a remote sensing system gathers data from the electromagnetic radiation emitted from an object or area, it produces a digital image in two or three-dimensional form. Information is then displayed as pixels, or picture elements. Smaller pixels provide better resolution, and thus more detail to a map. The images can be in black and white, color, or color infrared. In color infrared images, healthy green vegetation appears as bright red.

Have students read the Precision Agriculture Unit (#4074) listed in the recommended resources list. The information in this unit would be most helpful if it is assigned before the content of this objective is covered. Use TM: A8–7B to reinforce how remote sensing uses light waves to gather information. Display TM: A8–7C. It will be useful in reinforcing the types of images remote sensing can show.

Objective 3: Explain how precision farming uses remote sensing.

Anticipated Problem: How can precision farmers use remotely sensed data?

III. It is not possible to measure soil moisture content or phosphorus levels in plant leaves using remote sensing. Specific numerical data of any type cannot be gathered using this technology. However, the data can be inferred by using data analysis tools to find correlation between the data gathered by remote sensing, and actual measurements on the ground in
exact locations. Once this sensor data is matched with actual measurements, correlation can then be drawn over large areas of ground where ground measurements were not conducted. This is considered to be the greatest value of remote sensing, which is the ability to gather large amounts of data quickly with minimal labor input.

A. Vegetative properties such as crop progress, water stress, leaf damage, or nitrogen levels can be determined using remotely sensed maps known as **vegetative indices**. This can also be used to detect weed or insect pressure in an area. The differences within the map, or the differences from a specific time an area was remotely sensed to the next time sensing is done, can be used in analysis tools to determine which scenario could be causing the problem in the field.

B. Remote sensing is used primarily as one data layer in an entire **Geographic Information System** (GIS). All of the other layers, such as yield data, topography, crop scouting reports, crop varieties, and soil fertility assist the precision farmer in analyzing the remotely sensed data.

C. Ground-truthing must be done to verify variability within a remotely sensed area and to identify what problems are causing the variability. **Ground-truthing** is scouting an area that has been remotely sensed, and verifying that the information is accurate.

A variety of teaching methods can be used to reinforce student learning. Students will benefit from reading the text materials in order to better understand the content. Having students read the Precision Agriculture Unit (#4074) listed in the recommended resources would be helpful in reinforcing the content. A guest speaker from a retail chemical and fertilizer store would be a valuable resource, as would a producer involved in precision farming.

**Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used to determine which objectives need to be reviewed or taught from a different perspective.

**Evaluation.** Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance, on the application activity.

**Answers to Sample Test:**

**Part One: Matching**

1 = g, 2 = a, 3 = f, 4 = d, 5 = e, 6 = c, 7 = b, 8 = h

**Part Two: Completion**

1. Geographic Information System
2. Remote sensing
3. LANDSAT, SPOT
4. numerical
**Part Three: Short Answer**

The greatest value of a remote sensing system is the ability to analyze large areas quickly with limited labor input.
Lesson A8–7: Understanding Remote Sensing Technology

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. aerial photography  e. satellite imaging
b. spectral response    f. active system
c. passive system       g. frequency of coverage
d. pixels               h. ground-truthing

______  1. How often remote sensing can be done with a given system.
______  2. Remote sensing that can be done with aircraft.
______  3. A remote sensing system that sends and then detects its own signal.
______  4. Picture elements.
______  5. Remote sensing that must be done with satellites.
______  6. A remote sensing system that detects natural radiation emissions.
______  7. The reactions of wavelengths that are measured in remote sensing systems.
______  8. Personally observing areas to determine accuracy of remotely sensed maps.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. Remote sensing data is usually used as one layer of an entire ____________ ____________ ____________ that allows the producer to make educated decisions.

2. ____________ ____________ is a group of techniques used to collect information about an object or area without being there.

3. All satellite imaging must come from one of two systems, known as ____________ and ____________

4. Remote sensing cannot be used to determine ____________ data, but can show variations within a field or changes over time.
Part Three: Short Answer

Instructions. Provide information to answer the following question.

What is the greatest value of using remote sensing in a precision farming operation?
REMOTE SENSING

Aerial Photography

Satellite Imaging

REMOTE SENSING USING A SENSOR ARRAY

GROUND SWATH

Direction of movement

Field of view of linear array

Ground
REMOTE SENSING AND LIGHT WAVES

Interaction between electromagnetic radiation and a plant leaf
EXAMPLES OF REMOTE SENSING IMAGES

5/11/98
6/19/98
7/21/98
8/19/98
9/2/98