Increasing Food Production with Precision Agriculture

Grade Levels

6 - 8

Purpose

This hands-on lesson teaches students how precision agriculture uses geographic information systems (GIS) to help farmers ar manufacturers make smart, efficient, and responsible decisions about how and when they plant, grow, irrigate, harvest, and transport crops.

Estimated Time

60-75 minutes

Materials Needed

- *Increasing Production with Precision Agriculture* student handout, 1 per student
- *Increasing Production with Precision Agriculture* Teacher KEY
- *Increasing Production with Precision Agriculture PowerPoint*
- Calculators
- Agriculture is Under Pressure (https://www.youtube.com/watch?v=2jF2IsicDC4) video
- Kinze Autonomy Project: Harvesting System (https://www.youtube.com/watch?v=YFy6ZAjbeew&feature=related) video

For each lab group:

- Water bottle
- 1 Styrofoam cup
- 3 plastic cups
- Variety of straws (jumbo, regular, coffee).
- Various art supplies: Scissors, tape, rubber bands, paper clips, rulers

Essential Files (maps, charts, pictures, or documents)

- Increasing Production with Precision Agriculture (https://cdn.agclassroom.org/media/uploads/2019/07/15/Student_Worksheet_-_Increasing_Production_with_Precision_Agriculture.pdf)
- Increasing Production with Precision Agriculture PowerPoint (https://cdn.agclassroom.org/media/uploads/2016/08/23/Powerpoint_-_Increasing_Production_with_Precision_Agriculture.pptx)
- Increasing Production with Precision Agriculture Teacher KEY (https://cdn.agclassroom.org/media/uploads/2016/08/18/Increasing_Production_with_Precision_Agriculture_Teacher_KEY.p

Vocabulary Words

acre: a unit of area equal to 43,560 square feet (about the size of a football field)

bushel: a measure of capacity usually for dry goods equal to 64 pints

finite resources: resources that do not renew themselves at a sufficient rate (nonrenewable)

Global Positioning System (GPS): a space-based satellite navigation system that provides location and time information in weather conditions, anywhere on or near the Earth

irrigation: the artificial application of water to the land or soil

pivot: equipment used to irrigate fields (large sprinkler)

section: one square mile of land (640 acres)

variable rate irrigation: applies exactly the right amount of water to each foot/meter of the field

water use efficiency (WUE): the ratio of water used in plant metabolism to water lost by the plant through transpiration)

yield: measure of grains or seeds generated from a unit of land (agricultural output)

Did You Know? (Ag Facts)

- It is estimated that 9 billion people will inhabit the earth in 2050.[1]
- It is expected that food production will have to increase by 70% to feed an additional 2.3 billion people by 2050.[2]
- Farmers today produce 262% more food with 2% fewer inputs than they did in 1950.[3]

Background Agricultural Connections

How many people will inhabit the world in 2050? About 9.2 billion-- up from the 7 billion here today! And to make sure that everyone has enough to eat, global food production will need to increase by 70 percent. So how exactly will this be done? Precision agriculture is the answer!

Agriculture has changed dramatically throughout the past years. In the past, almost everyone was a farmer. These farmers produced a variety of crops and livestock that they fed to their immediate families. Today, only 2% of the population is involv in production agriculture. These farmers have specialized operations and feed 155 people (Prax, 2010).

Key STEM IDEAS

Engineering allows us to define and solve real-world problems. Engineering concepts are changing agriculture by applying technology to improve food production. New equipment allows farmers to put in less labor to achieve larger yields. Precision agriculture is a farming management concept based on observing, measuring, and responding to inter- and intra-field variabilit in crops. **Variable rate irrigation** is a type of precision agriculture that involves applying water at a variable rate along the center **pivot** rather than one uniform rate along the entire length of the system. Variable rate irrigation has many uses for applying water at different rates to wet areas, different soil types, and overlapping pivots.

Connections to Agriculture

Variable rate irrigation is made possible by the use of the **GPS**, field computer, rate controller, telematics, and a meter. GPS is used by farmers to create field maps to determine a field's boundaries. Field computers allow farmers to control the applicatior fertilizers, herbicides, and pesticides through automated delivery systems. Farmers are able to monitor yields and moisture usi computers. Rate controllers make it possible for farmers to control how much irrigation, fertilizer, etc. is applied in a field. Telematics allows information collected in a field to be transferred in the internet.

Water use efficiency is calculated by determining the difference between irrigated yield and dryland yield and dividing that b the irrigation in inches. By performing these calculations, farmers will discover how much they should irrigate a **section** in ord to increase yields and save water.

Interest Approach - Engagement

1. Ask students if they know the current population of the world. *(approximately 7 billion)*
2. Ask, "Is our population increasing or decreasing?" *(increasing)* Inform students that it is estimated that we will have 9 billio people by the year 2050. Farmers will need to grow as much food in the next 50 years as they did in the past 10,000 years combined.[1]
3. Ask students, "What necessities will we need more of in order to accommodate 2 billion additional people on the earth?" *(food, water, energy, goods, and medical technologies, etc.)*
4. Explain that we will need to find solutions to feed a growing population. With limited resources (arable land, water, plant nutrients, etc.), we must do more with less without degrading our natural world. Precision agriculture is the answer to increasing yields without increasing resources. Inform students that they will be learning what precision agriculture is and how engineers develop these technologies.

Procedures

Activity 1: Introduction

1. Following the *Interest Approach* students should begin to have an idea of the significance of the projected population growt in our world. Ask students to begin thinking about the overall impact of population growth as they watch the video, Agriculture is Under Pressure (https://www.youtube.com/watch?v=2jF2IsicDC4).

2. Following the video, ask the class what the overall message is or what stuck out to them. Lead the discussion to conclude that farmers need to produce more food using the same resources.
3. Introduce the word *efficiency*. Discuss the definition and give real-life examples of efficiency that students will relate to. Poi out that farmers will need to be more and more efficient to keep up with the demand for food.
4. Ask students what type of resources farmers need in order to produce our food. As you discuss the following resources, poir out that they are limited. We can't obtain more. Therefore, we need to be more efficient in our use of them.
   - Open space to grow crops or raise livestock
   - Water
   - Arable soil (soil containing adequate nutrients, a proper growing climate, and appropriate soil texture for plant growth)
5. Point out that farmers have become more efficient in previous years through the use of technology. Ask students, "What ar some examples of technology that farmers are using today?" (*Students may discuss GPS, maps, cell phones, automated irrigation systems, computers, large machinery (tractors) with automated features, etc.)*
6. Introduce the concept of *precision agriculture*. Explain that precision agriculture implements various technological instruments to make agriculture more precise and efficient. As an example show the video clip Kinze Autonomy Project: Harvesting System (https://www.youtube.com/watch?v=YFy6ZAjbeew&feature=related). As the video clip plays ask studer what they notice is different about the tractor *(there isn't a driver.)* Explain that this tractor is operated using robot and GP technology. This allows a single worker to harvest an entire field.

7. Introduce a second example of precision agriculture, *variable rate application* or (VRA). With VRA, different rates of an inpu such as water, seed, or fertilizer can be applied to a field to match the needs of each specific area. Show the first 3 minutes of the video clip, Precision VRI (https://www.youtube.com/watch?v=a7EsG6Q8mVA) to explain and illustrate the unique components in each field that impact the water needs.

8. Following the video, summarize why farmers would want to use variable rate irrigation.
    - Increase crop yields. Too much or too little water decreases plant health and crop yield.
    - Conserve water.
    - Provide exact and precise watering for each soil type and slope within a field. *(Soil type can vary within a field. Clay soil holds high amounts of water which allows the roots to soak in the water for a longer time. In sandy soils, water can quickly run through the soil without penetrating the roots).*
        - Use slide 2 of the *Increasing Production with Precision Agriculture* PowerPoint to give clarification on how soil type affects water holding capacity.
        - Use slide 3 to show a picture of a field being watered uniformly. Ask students if they can see a section of the field that needs more water.
9. Use slides 4-7 to summarize key points in preparation for the next activity.

Activity 2: Calculating WUE and Building a VRI System

1. Give each student one copy of the *Increasing Production with Precision Agriculture* student handout.
2. Complete "Part 1" of the handout. This section can be completed as a class, in groups, or individually. Slides 9-19 walk through the worksheet step-by-step.
3. Move on to "Part 2" of the handout. Guide students through the instructions for the variable rate irrigation activity in the student handout. Using slides 20-25, explain to students that they will build a device to vary water flow (just like in variable rate irrigation). Their goal is to build a system to divide 16oz of water into three cups with 2 oz., 6 oz., and 8 oz. of water in each.
4. Form students into groups of three. Distribute a 16 oz. water bottle, 3 cups, scissors, and a choice of straws or other materials to each group.
5. Using slide 25, discuss the engineering design process with students and have them complete page 4 of the handout.
6. Give students 10 minutes to construct a device to simultaneously divide the water into 3 different amounts. Allow students to test their design and share it with the class.
7. After their designs have been tested, instruct students to complete page 5 of their handout.

Concept Elaboration and Evaluation:

Encourage students to reflect on the activity using class discussion by asking the following reflection questions:

- Was your design successful?
- What could you do to improve your design?
- What career could you choose that uses these skills to develop instruments used in precision agriculture?
- Why is precision agriculture important?

Summarize the lesson with the following key points:

- Technology has developed and improved through time. It helps farmers/ranchers provide more food to more people.
- Using technology in agriculture decreases negative environmental impacts in our world.

We welcome your feedback (https://usu.co1.qualtrics.com/jfe/form/SV_4HhIVpN4L8IC2lT)! Please take a minute to tell us how to make this lesson better or to give us a few gold stars!

Enriching Activities

- Watch the Variable Rate Technology (https://www.youtube.com/watch?v=8eXMG_VOGIY) video clip to see how VAR technology is also used to seed fields and apply fertilizers more efficiently.

- Assign students to read individually, or share with the class the online article from Modern Farmer, 8 Hot Farm Tech Start-U (http://modernfarmer.com/2014/02/10-silicon-valley-agriculture-start-ups/). Students will learn about eight specific technology applications used in agriculture.

Sources

1. http://www.un.org/en/development/desa/news/population/un-report-world-population-projected-to-reach-9-6-billion-by-2050.html (http://www.un.org/en/development/desa/news/population/un-report-world-population-projected-to-reach-9-6-billion-by-2050.html)
2. http://www.fao.org/news/story/en/item/35571/icode/ (http://www.fao.org/news/story/en/item/35571/icode/)
3. Producing Fruits: The Technology of Farming, 2013

Suggested Companion Resources

- Agricultural Drones (https://agclassroom.org/matrix/resource/923/)
- The Most Magnificent Thing (https://agclassroom.org/matrix/resource/906/)
- Crop Cards (https://agclassroom.org/matrix/resource/797/)
- Crop Intensity Maps (https://agclassroom.org/matrix/resource/966/)
- Agricultural Engineering Video (https://agclassroom.org/matrix/resource/148/)
- Eat Happy Project video series (https://agclassroom.org/matrix/resource/822/)
- Fighting Weeds: Can we reduce, or even eliminate herbicides by utilizing robotics and AI? (https://agclassroom.org/matrix/resource/972/)
- Precision Agriculture Technologies and Factors Affecting Their Adoption (https://agclassroom.org/matrix/resource/854/)
- SupraSensor Could be Super Tool for Precision Agriculture (https://agclassroom.org/matrix/resource/774/)
- The Future of Farming & Agriculture video (https://agclassroom.org/matrix/resource/834/)
- What Happens When Farming Goes High-Tech? (https://agclassroom.org/matrix/resource/957/)
- Dirt to Dinner (https://agclassroom.org/matrix/resource/956/)
- Esri GIS for Agriculture (https://agclassroom.org/matrix/resource/716/)
- Irrigation Museum (https://agclassroom.org/matrix/resource/745/)

Author

Molly Brandt and Erin Ingram

Organization Affiliation

University of Nebraska-Lincoln