Precision Agriculture

Grade Level: 4-8

Lesson Overview

When you think of a farmer, do you imagine a person sitting in a tractor watching the implement behind them while the tractor steers itself? Someone operating an unmanned aerial vehicle (UAV) to gather crop data in the field? A person at a computer analyzing field maps to calculate fertilizer needs? Believe it or not, these scenarios are typical on many of today's farms. This lesson delves into precision agriculture, which uses various technological tools to ensure crops receive exactly what they need for optimum health and productivity.

Student Objectives

1. Determine the benefits and adoption of precision agriculture components by farmers.
2. Identify the various components of precision agriculture.
3. Express their thoughts concerning precision agriculture.
4. Calculate and compare crop fertilizer needs using traditional vs. precision application technologies.

Materials

- ✓ Understanding Precision Agriculture information sheet
- ✓ Key Components of Precision Agriculture worksheet
- ✓ Calculating Fertilizer Needs by Type of Application worksheet

Vocabulary

- **autonomous vehicle** - a vehicle that can guide itself without a human operator
- **auto steer** - a system incorporating remote sensing and global positioning system GPS that provides precise steering to maximize fuel efficiency and crop inputs in tillage and planting operations of farm fields.
- **boundary mapping** - recording the boundaries of the fields through use of the Global Positioning System.
- **fertilizer** - any of a large number of natural and synthetic materials, including manure and nitrogen, phosphorus, and potassium compounds, spread on or worked into soil to increase its capacity to support plant growth.

- **geographical information system (GIS)** - a computerized data management system used to capture, store, manipulate, analyze, manage, and display spatial information.
- **georeferenced** - associating some piece of information (yield, pH, soil nitrogen, etc.) with a field position in two-dimensional space; latitude and longitude.
- **global positioning system (GPS)** - a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth.
- **pesticide** - any chemical or biological substance used for preventing, destroying, or repelling any plant or animal pests; herbicides, insecticides, fungicides, rodenticides, etc.
- **precision agriculture** - an information technology-based, site-specific farm management system that collects and responds to data ensuring that crops receive exactly what they need for optimum health and productivity.
- **remote sensing** - the utilization at a distance (as from aircraft, spacecraft, satellite, or ship) of any device for gathering information about the environment.
- **robot** - a mechanical device that can perform a variety of tasks on command or according to instructions programmed in advance.
- **satellite** - any object that orbits another object.
- **sensor** - a device which detects or measures a physical property and records, indicates, or otherwise responds to it.

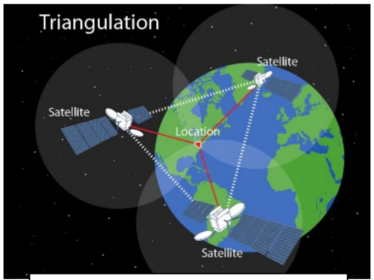


Illustration by Tim Gunther, National Geographic

- **smart farming** - data driven management decisions.
- **triangulation** - a method of determining the location of an unknown point, as in GPS navigation, by using the laws of plane trigonometry.
- **unmanned aerial vehicles (UAVs)** - an aircraft piloted by remote control or onboard computers; sometimes called a drone.
- **variable rate technology (VRT)** - a method of applying varying rates of a material in appropriate zones throughout a field based on the precise location or qualities of the area.
- **yield** - measure of grains or seeds generated from a unit of land (agricultural output).
- **yield monitor** - yield monitors have the capability of indicating yield (bushels per acre), wet and dry bushels, total pounds, acres/hour, acres worked, and grain moisture content. This is all done while the combine is in use, and can be

recorded on a memory card for later analysis, mapping, etc. All information becomes site-specific when used with a global positioning system.

Procedure

1. Use the Understanding Precision Agriculture information sheet to introduce and facilitate class discussion.
2. Have students complete the Key Components of Precision Agriculture worksheet. Answers may be found in the Understanding Precision Agriculture information sheet.
3. To further explore, have students complete the Calculating Fertilizer Needs by Type of Application. Depending on the math level of the students, it may be helpful for the teacher to help get them started with the first calculations.

   To introduce this activity, ask students to think about school lunches. Hypothetically what if a school cafeteria served the same amount of food to each student preschool through high school. Potentially preschoolers and early elementary students would get more food than they could eat resulting in food being wasted. The younger students are full and bursting with energy. It may be closer to a normal size portion for 4th-8th graders. Unfortunately, most high schoolers would probably not get enough. These students may leave hungry and run out of energy. This is the way it is with soil. Some areas need more fertilizer than others. Some areas are just right. Some areas don’t need any fertilizer. For soil to produce it’s best just like you, it needs to be “fed” or fertilized the right amount.

Extension Activities

1. Class may research various precision agriculture tools and prepare a report for the classroom. The class could make a precision agriculture book, including each of the researched tools and a drawing or image of each.
2. Search “precision agriculture companies” online. Choose a company, explore their website, and summarize what tools the company provides for farmers. Ideas of information students could gather:
   - name of company
   - web address
   - when founded
   - name & describe a tool/technology the company provides
   - how does this technology help farmers?
   - how does this technology help the environment?
   - how does this technology help society?

3. Explore career opportunities in Precision Agriculture and related areas.

   https://www.ilaged.org/ag-career-websites

   https://courseadvisor.com/careers/precision-agriculture-technicians-focus/

   https://www.agcareers.com/career-profiles/precision-agriculture-specialist.cfm

   https://www.agriculture.purdue.edu/USDA/careers/pdfs/Remote%20Sensing%20Spec.pdf

Additional Resources

- https://www.gps.gov/applications/agriculture/ Official U.S. government information about the Global Positioning System (GPS) and related topics
- https://www.youtube.com/watch?v=IoRQiNFzT0k How GPS works video from Discovery News
- https://www.youtube.com/watch?v=8eXMG_VOGIY Variable Rate Technology Productive and Environmental video
- https://youtu.be/tbkTi3zNN9s What Happens When Farming Goes High-Tech? National Geographic video
- https://www.agclassroom.org/matrix/lesson/613/ GPS & GIS Technology in Agriculture lesson on the National Agriculture in the Classroom matrix
- https://www.agclassroom.org/matrix/lesson/656/ High Tech Farming lesson on the National Agriculture in the Classroom matrix
- https://www.agclassroom.org/matrix/lesson/513/ Increasing Food Production with Precision Agriculture lesson on the National Agriculture in the Classroom matrix
- https://www.agclassroom.org/matrix/lesson/688/ Drones in High-Tech Farming lesson on the National Agriculture in the Classroom matrix
- https://www.youtube.com/watch?v=qexChWNFY5E Journey 2050 Technology & Innovation video
- https://www.youtube.com/watch?v=Qmla9NLFBvU The Future of Farming & Agriculture video highlights technological advancements in both animal and plant agriculture
- https://timeandnavigation.si.edu/ The Smithsonian Institution's Time and Navigation online teaching resources and multimedia related to GPS

Standards

Illinois Mathematics Standard

CC.6.RP.3 Understand ratio concepts and use ratio reasoning to solve problems. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

Illinois Science Standard

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Illinois English Language Arts Standard

RST 1: Cite specific textual evidence to support analysis of science and technical texts.

The **M**ultidisciplinary **AG**ricultural **I**ntegrated **C**urriculum (mAGic) was created in 2004 under the leadership of the Illinois State Board of Education (ISBE) and the Facilitating Coordination in Agricultural Education Project (FCAE). Funding was made available through the FCAE grant budget from the agricultural education line item of the ISBE budget. This revision, as printed, was developed in September 2021.

These mAGic lessons are designed to bring agriculture to life in your classroom. They address the Illinois Learning Standards in math, science, English language arts and social studies.

Machines mAGic project update writers/reviewers: Rhodora Collins – Dekalb County; Suzi Myers – Kane County; Connie Niemann – Montgomery County; Debbie Ruff – Livingston County; Jennifer Waters – Sangamon County; and Dawn Weinberg – Hancock County.

Understanding Precision Agriculture

When you think of a farmer, do you imagine…

- …someone sitting in a tractor watching the implement behind them while the tractor steers itself?
- …a farmer operating a combine while watching a monitor showing yield data?
- …a person taking soil samples using GPS to grid map a field?
- …someone operating an unmanned aerial vehicle (UAV or drone) to see where the crop is thriving and where it is not?
- …someone on a laptop analyzing field maps to determine fertilizer needs?

This tractor has a GPS receiver on its roof. It sends information to a monitor inside the cab, allowing the operator to see exactly where they are in the field.

Believe it or not, these scenarios are typical on many farms today. Farmers around the country use satellite and remote sensing data to more effectively and efficiently manage their cropland. This is called “precision agriculture.”

What is Precision Agriculture?

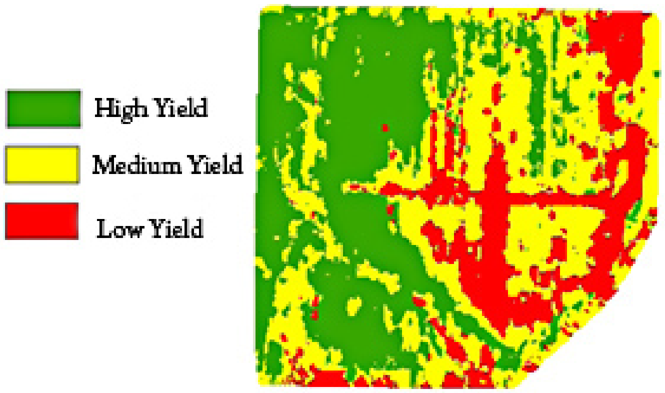
Precision agriculture is an information technology-based, site-specific farm management system. It works by collecting and responding to data so that crops receive exactly what they need for optimal health and yield.

Precision agriculture is made possible by combining global positioning systems (GPS) and geographical information systems (GIS). GPS-based applications in agriculture are used for farm planning, field mapping, soil sampling, guidance systems, crop scouting, variable rate technology, and yield mapping.

More about GPS and GIS

The global positioning system (GPS) is a network of 24 satellites developed for and managed by the U.S. Department of Defense. These satellites transmit precise time and location information to ground-based receivers. The ground-receiving units collect this information from multiple satellites at once for use in calculating a triangulation fix, thus determining the exact location of the ground-based receiver.

A geographical information system (GIS) is a computerized data management system. It is used to gather, store, analyze, manage, and display information related to locations on the Earth’s surface. GIS systems are used by individuals, companies, organizations, and government agencies to map and track information by location. Droughts, voting behavior, and animal migration are all examples of information that can be mapped using GIS.



Map showing crop yields across a field (USDA ARS)

GPS and GIS on the Farm
Mapping the location, size, shape, and layout of a farm field is another example of how GPS and GIS can be used. Once this information is compiled in a GIS database, an image of the field can be generated. This image, or map, can include various layers of information, such as roads and streams, field boundaries, soil types, crop density, and crop yield. This data all comes into play in the use of additional forms of precision farming technology, including GPS guidance systems, variable rate technology (VRT), and yield monitors.

GPS Guidance Systems
GPS guidance systems allow tractors, applicators, and harvest equipment such as combines to be steered automatically along precise, predetermined paths. Because the guidance system constantly pinpoints the exact location in the field, it allows for perfect placement of seeds during planting, precise application of crop protectants without skips or overlaps, and tracking of yields during harvest. GPS-enabled automatic steering also reduces operator fatigue.

Variable Rate Technology (VRT)
Variable rate technology (VRT) allows farmers to apply seed, fertilizer, crop protectants, or even irrigation at different or varying rates across a field. Soil and crop characteristics can change significantly throughout a field, so VRT allows for placement of the right product, in the right place, and in the right amount.

There are two types of VRT systems: map-based and sensor-based. Map-based VRT is the most widely used. This system uses a pre-generated map of a field to adjust product application. The map is imported to an on-board computer, where GPS data tells the equipment how much product to apply as it moves across the field. The operator can watch the map during application, as it displays on a monitor within the cab.

Sensor-based VRT does not use maps. Instead, sensors mounted on the application equipment measure soil properties or crop characteristics in real time. The control system constantly calculates and applies the amount of product required as the applicator moves across the field.

Using variable rate technology has several benefits, including:

- Optimization of crop yield, when a precise amount of nutrients is combined with ideal seeding rate during planting
- Environmental sustainability, because seed, fertilizer, chemical, and water waste are reduced or eliminated
- Crop traceability, because VRT's digitized information makes it possible to trace the history of everything applied to the fields; this can play an important role in helping farmers be competitive in the marketplace.


VRT fertilizer spreader (DeKalb County Farm Bureau)

Yield Monitors
The amount of a crop produced in a given area is known as yield. For row crops such as corn, soybeans, and wheat, yield is measured in bushels per acre.

A yield monitor is a device installed within a harvesting machine such as a combine. As it moves through a field, sensors on the combine measure and record the flow of grain into the grain tank, the moisture level of the grain, and the position of the combine in the field via GPS. The combine operator can see this information displayed on a monitor in the cab. This data is then used to generate a yield map of the field.

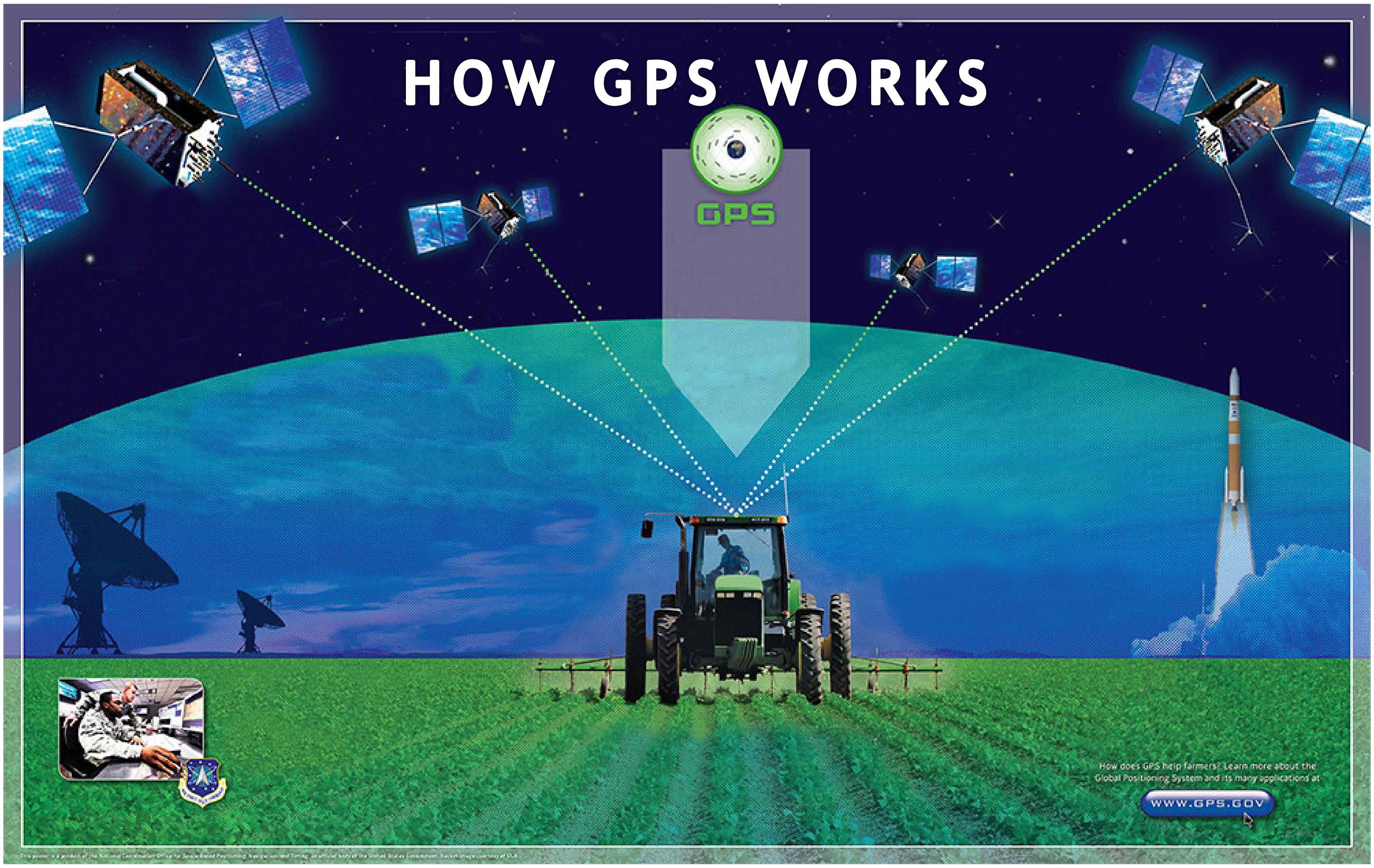
Analyzing yield is the most important way a farmer can determine the effectiveness of the crop management decisions they have made throughout the season.

Crop Production and Beyond
Precision agriculture is not a single technology. Rather, it is a group of technologies that can be combined as a system. Farmers choose the technology components that make the most economic sense for their farms. Several factors influence the choice of technology components farmers invest in and use. These factors include (but are not limited to) farm size; characteristics such as field size, soil types, and terrain; and personal preference.

The number of farmers using precision agriculture technology to micromanage their fields continues to increase. The USDA Economic Research Service notes, "Precision agriculture technologies require a significant investment of capital and time, but may offer cost savings and higher yields through more precise management of inputs." In other words, adopting precision farming tools is expensive, but can pay off in savings and efficiency.

Additional precision ag technologies are available or in development, including unmanned aerial vehicles (drones), remote sensing, autonomous tractors, and robotic pest control devices. Such technologies are not limited to crop production. GPS-enabled livestock monitors, virtual fencing, automatic feeders, and robotic milking machines are examples of technology tools available for use in livestock production.

Reference: [What is Geographic Information Systems (GIS)?](#) (gisgeography.com)



HOW GPS WORKS

1. GPS satellites broadcast radio signals providing their locations, status, and precise time from on-board atomic clocks.
2. The GPS radio signals travel through space at the speed of light, more than 299,792 km/second.
3. A GPS device receives the radio signals, noting their exact time of arrival, and uses these to calculate its distance from each satellite in view.
4. Once a GPS device knows its distance from at least four satellites, it can use geometry to determine its location on Earth in three dimensions.

GPS is a constellation of 24 or more satellites flying 20,350 km above the surface of the Earth. Each one circles the planet twice a day in one of six orbits to provide continuous worldwide coverage.

The GPS Mission Control Station tracks the satellites via a global monitoring network and manages their health on a daily basis.

Ground antennas around the world send updates and operational commands to the satellites.

The Air Force launches new satellites to replace aging ones when needed. The new satellites offer upgraded security and accuracy.

A poster containing the above images and information may be downloaded or ordered at www.gps.gov.

Name ______________________________

Key Components of Precision Agriculture

Complete the graphic organizer by filling in the blanks utilizing information from Understanding Precision Agriculture.

Precision Agriculture

1. ____________________
A network of satellites developed for and managed by the U.S. Dept. of Defense; transmits precise time and location information to ground-based receivers

2. ____________________
Computerized management system used to gather, store, analyze, manage, and display information related to locations on the Earth's surface

3. ____________________
System that enables tractors, applicators, and harvest equipment to be steered automatically along predetermined paths allowing for precise placement of seed, fertilizer, or crop protectants

4. ____________________
Device installed within a combine which measures and records the flow of grain into the grain tank as well as the grain's moisture level while tracking the machine's position in the field

5. ____________________
Technology that allows application of seed, fertilizer and crop protectants at varying rates across a field, thus enabling yield optimization, environmental sustainability, and crop traceability

6. ____________________
Images generated by a yield monitor using GPS and GIS technology which allow farmers to analyze the effectiveness of their crop management decisions

Key Components of Precision Agriculture ANSWER KEY

Complete the graphic organizer by filling in the blanks utilizing information from Understanding Precision Agriculture.

Precision Agriculture

Global Positioning System (GPS)

A network of satellites developed for and managed by the U.S. Dept. of Defense; transmits precise time and location information to ground-based receivers

Geographic Information Systems (GIS)

Computerized management system used to gather, store, analyze, manage, and display information related to locations on the Earth's surface

GPS Guidance Systems

System that enables tractors, applicators, and harvest equipment to be steered automatically along predetermined paths allowing for precise placement of seed, fertilizer, or crop protectants

Yield Monitor

Device installed within a combine which measures and records the flow of grain into the grain tank as well as the grain's moisture level while tracking the machine's position in the field

Variable Rate Technology (VRT)

Technology that allows application of seed, fertilizer and crop protectants at varying rates across a field, thus enabling yield optimization, environmental sustainability, and crop traceability

Yield Maps

Images generated by a yield monitor using GPS and GIS technology which allow farmers to analyze the effectiveness of their crop management decisions

Name ________________________

Calculating Fertilizer Needs by Type of Application Worksheet

Let's say we are growing a corn crop and need to calculate the amount of fertilizer needed. We will be calculating traditional fertilizer application compared to Variable Rate Application (VRT). Here is the information given:

Size of field: 40 acres

Product to be applied: Potash 0-0-60

Crop to be planted: Corn

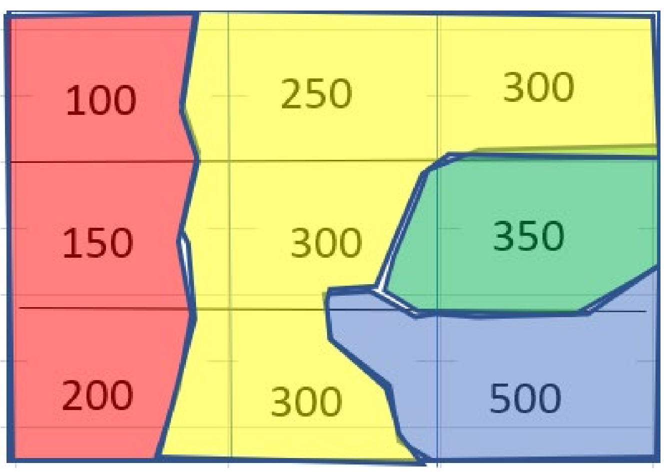
Anticipated yield per acre: 200 bushels per acre (80 pounds potash needed per acre)

Potash build level: 350 pounds (building soil test values to an optimum value of 350)

Cost of potash per ton: $500

Field average for map below = 272 pounds (lbs.) of potash

Potash Soil Test Results (grids)



KEY

RED indicates a lower value (needs most amount of fertilizer)

YELLOW indicates a normal amount (some fertilizer will be needed)

GREEN indicates a higher reading (a little fertilizer may be needed)

BLUE indicates a very high reading (no fertilizer is needed)

Note that even though each grid is represented with a number, in reality, the actual nutrient pattern in the soil will not be "grid like". To create the actual representation in the field, each sample "feathers" out and takes into consideration the results of surrounding samples, therefore, creating an actual representation of the field nutrients and where they lie. The map is color coded to reflect this.

Area	Total Acres	Results by Number of Acres
Red area	10 acres	100 lbs.=3 acres; 150 lbs.=4 acres; 200 lbs.=3 acres
Yellow area	15 acres	250 lbs.=3 acres, 300 lbs.=12 acres
Green area	7 acres	350 lbs.=7 acres
Blue area	8 acres	500 lbs.=8 acres
Total	40 acres	

This activity and some resources for this lesson were provided by Elaine Frerichs, Information Management Systems Manager for M&M Service Company.

Traditional Fertilizer Application

To calculate how much potash, we will need for this field, we will need to account for two components:

- BUILD: building the soil to an average level (to bring it up to a productive level).
- CROP MAINTENANCE: fertilizer needed for the crop we are going to plant.

1. Calculate how many pounds of potash are needed to build the soil. Use the formula given with the information shared on previous page.

   (_____________ - _____________) x _____________ = _______________

   potash build level **field average** **size of field** **potash needed**

2. Calculate the following percentages for each of the field areas (colored areas).

   a. What percentage of the field needs the most fertilizer? Hint look at the map colors and bottom chart on previous page.)

   __________________________ / _____________ = __________________

   acres needing most fertilizer **size of field** **% of the field (most)**

   b. What percentage of the field needs a normal amount of fertilizer?

   c. What percentage of the field needs very little or no fertilizer?

3. Calculate how many pounds of potash are needed for crop maintenance? Use the formula given with the information shared on the previous page.

   ________________________ x ____________ = ______________________

   lbs. needed for 200 bushels of corn yield per acre **size of field** **lbs. for crop maintenance**

4. How many total pounds of potash are needed for this field? Hint: keep in mind the two components were build (#1) & crop maintenance (#3).

5. How much will it cost to fertilize the field using traditional fertilizer application? (Keep in mind there are 2,000 pounds in 1 ton.)

   _______________ / ___ ________ = ____________ x _________ = _________

   total lbs. needed **# lbs. in ton** **tons needed** **$ per ton** **cost**

   How much will it cost per acre?

6. In thinking about how many pounds of potash you figured in #1 are needed compared to the percentages you calculated in #2, what do you think about the amount of money spent on the field?

Using Variable Rate Technology (VRT) - placing the right product in the right place in the right amount

We will use the same steps but treat the areas as “mini fields” versus one large field.

7. Calculate how many pounds of potash are needed to build the soil. Use the formula shown for green area below with the information shared on first page.

   a. Red area

   b. Yellow area

   c. Green area

(__________	- __________)	x ________	= ______________
potash build level	**green potash level on map**	**# acres in green area**	**lbs. needed to build green area**

   d. Blue area

   e. How much total potash is needed using variable rate application to build the soil?

8. How much total potash is needed for this field? (Hint: Keep in mind the two components were build & crop maintenance) Use the crop maintenance from #4.

9. How much will it cost to fertilize the field using Variable Rate Technology? (Keep in mind there are 2,000 pounds in a 1 ton.)

   How much will it cost per acre?

Calculating Fertilizer Needs by Type of Application ANSWER KEY

Traditional Fertilizer Application (not VRT)

To calculate how much potash, we will need for this field, we will need to account for two components:

- BUILD: building the soil to an average level (to bring it up to a productive level).
- CROP MAINTENANCE: fertilizer needed for the crop we are going to plant.

1. Calculate how many pounds of potash are needed to build the soil. Use the formula given with the information shared.

   (350 lbs. - 272 lbs.) x 40 acres = 3,120 lbs. potash
   potash build level   field average   size of field   potash needed

2. Calculate the following percentages for each of the field areas (colored areas).

   a. What percentage of the field needs the most fertilizer?
      10 acres / 40 acres = 25% of the field

   b. What percentage of the field needs a normal amount of fertilizer?
      15 acres / 40 acres = 37.5% of the field

   c. What percentage of the field needs the very little or no fertilizer?
      (7 acres + 8 acres) / 40 acres = 37.5% of the field

3. Calculate how many pounds of potash are needed for crop maintenance? Use the formula given with the information shared.

   pounds of potash needed for anticipated 200 bushels of corn yield per acre x total number of acres in field

   80 lbs. per acre x 40 acres = 3,200 lbs. potash
   lbs. needed for 200 bushels of corn yield per acre   size of field   lbs. for crop maintenance

4. How many total pounds of potash are needed for this field? (Hint: keep in mind the two components were build & crop maintenance.)

   3,120 lbs. (build) + 3,200 (crop maintenance) = 6,320 lbs. of potash

5. How much will it cost to fertilize the field using traditional fertilizer application? (Keep in mind there are 2,000 pounds in a 1 ton.)

6,320 lbs.	/	***2000 lbs.***	=	***3.16 tons***	x	***$500***	=	***$1,580***
total lbs. needed		**# lbs. in ton**		**tons needed**		**$ per ton**		**cost**

How much will it cost per acre? ***$1,580 / 40 acres = $39.50***

6. In thinking about how many pounds of potash you figured in #1 are needed compared to the percentages you calculated in #2, what do you think about the amount of money spent on the field?

Accept any reasonable answer. In this scenario we are applying 78 pounds of fertilizer over all areas. So, the 10 acres shown in red that needed more fertilizer are short of what they need which limits crop potential. The 15 acres shown in yellow that needed a normal amount received what they needed. This leaves 15 acres shown in green and blue that were over fertilized. In other words, 25% of the fertilizer dollars spent are under-utilized and 37.5% are over utilized.

Using Variable Rate Technology (VRT) - placing the right product in the right place in the right amount

We will use the same steps but treat the areas as “mini fields” versus one large field.

7. Calculate how many pounds of potash are needed to build the soil? Use the formula given with the information shared.

Build Level minus Potash Level on the Map x Number of Acres

a. Red area
(350 lbs. - 100 lbs.) x 3 acres = 750 lbs. potash
(350 lbs. - 150 lbs.) x 4 acres = 800 lbs. potash
(350 lbs. - 200 lbs.) x 3 acres = 450 lbs. potash
total potash needed for Red area = 2,000 lbs. potash

b. Yellow area
(350 lbs. - 250 lbs.) x 3 acres = 300 lbs. potash
(350 lbs. - 300 lbs.) x 12 acres = 600 lbs. potash
total potash needed for Yellow area = 900 lbs. potash

c. Green area

(350 lbs.	-	***350 lbs.)***	x	***3 acres***	=	***0 lbs.***
potash build level		**green potash level on map**		**# acres in green area**		**lbs. needed to build green area**

d. Blue area
(350 lbs. - 500 lbs.) x 8 acres = 0 lbs. potash for blue area

e. How much total potash is needed using variable rate application to build the soil?
2,000 lbs. (red) + 900 lbs. (yellow) + 0 lbs. (green & blue) = 2,900 lbs.

8. How much total potash is needed for this field? (Hint: Keep in mind the two components were build & crop maintenance) Use the crop maintenance from #4.

   2,900 lbs. (build) + 3,200 (crop maintenance) = 6,100 lbs. of potash

9. How much will it cost to fertilize the field using Variable Rate Technology? (Keep in mind there are 2,000 pounds in a 1 ton.)

   6,100 lbs. of potash / 2000 lbs. in 1 ton = 3.05 tons x $500 = $1,525 for potash

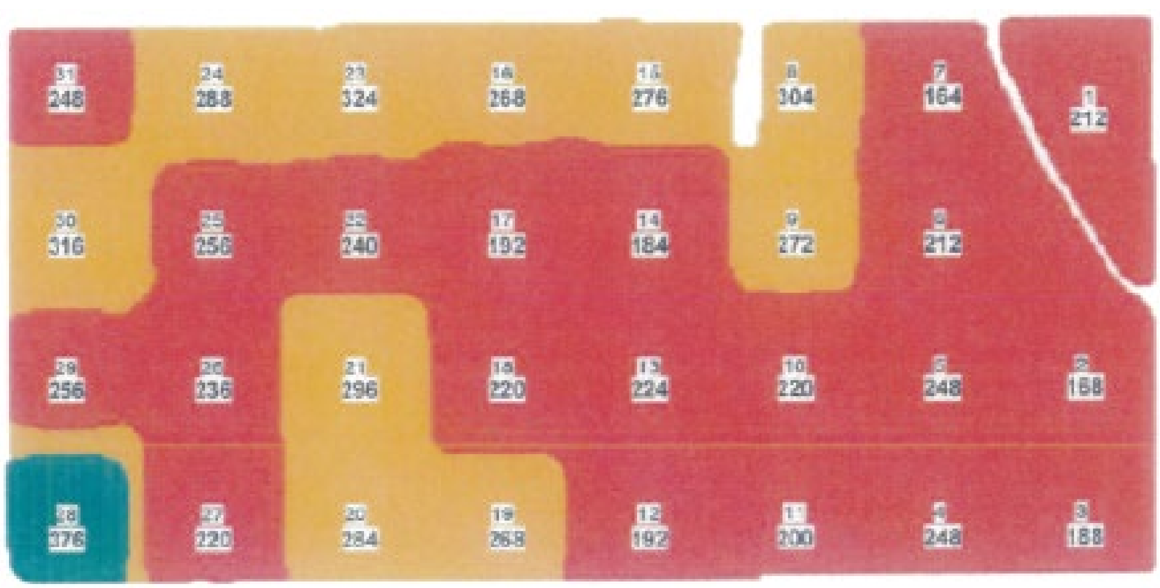
   How much will it cost per acre? ***$1,525 / 40 acres = $38.13***

Things to keep in mind about the Calculating Fertilizer Needs by Type of Application worksheet.

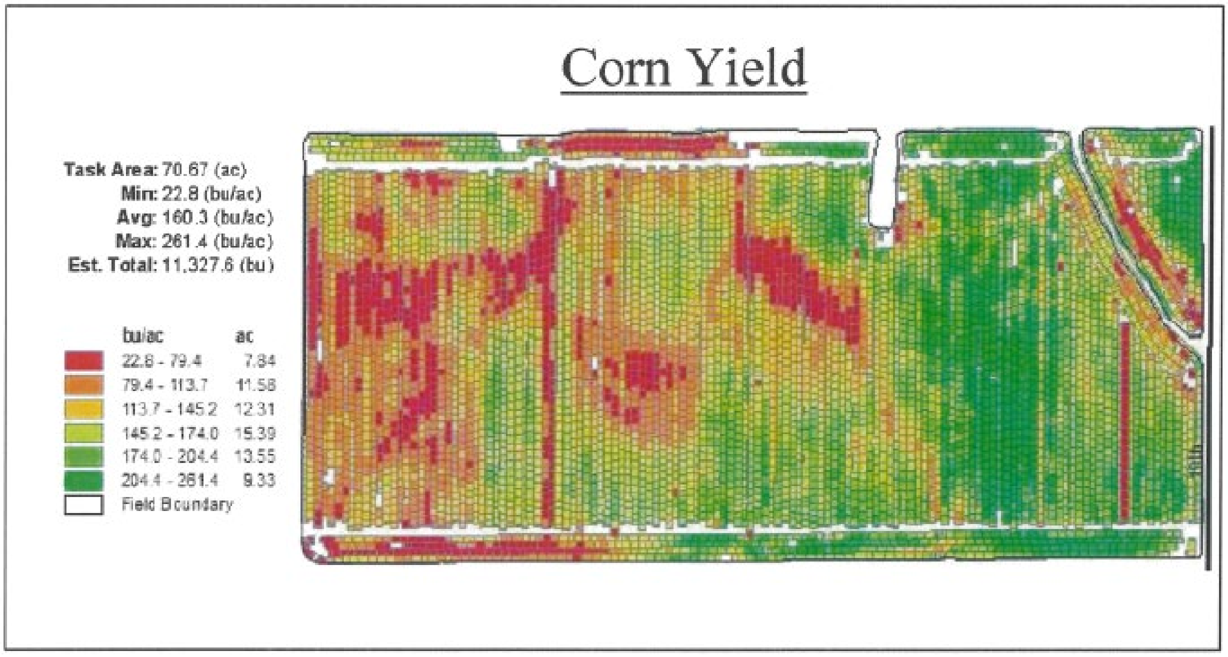
- ❖ Actual yields vary throughout the field. For simplicity purposes, we used an average yield for this example. In reality, each area of the field's actual harvest data can be used in the variable rate calculations, just as the soil test data was.
- ❖ Only one nutrient - potash was used in this example. In reality, this would need to be done for each nutrient the crops need such as phosphorus, lime, nitrogen, etc.
- ❖ This scenario imitated basic calculations. In reality, other agronomy numbers would need to be incorporated for actual product calculations. These factors along with actual harvest data, typically creates a much wider range in Variable Rate Technology savings/efficiency/productivity than our example.
- ❖ Soil samples were used in this scenario to vary the rate of fertilizer. In reality, other crops or layers can be and are used to vary the rate of fertilizer. Some examples are yield data, soil types, imagery (satellite, aerial, or drone), etc.
- ❖ This is a sample of an actual Variable Rate Technology (VRT) calculation. Software mapping programs will calculate and process these numbers in a matter of minutes. As you will notice, it is a little more complex than our sample problems.

```
if (K_mehlich3<K_Build) then apply
(K_Build-K-mehlich3)*4/Applications to build K + CornHarvest * .28;
elseif (K-mehlich3>=K_Build and  K_mehlich3 <K_Maintenance) then apply Cornharvest * .28;
else apply (0).
```

Actual Potash Soil Test Result



Actual Corn Yield Data Map for this Soil Test



Note: You can see how the yields vary across the field- higher producing areas versus lower producing areas.

Actual Variable Rate Technology Potash Map Created