Agriculture Education & Advocacy

Lesson 4: Agricultural Technology: Farming in the 21st Century

Grade Level & Subject: 6-8 / Life Sciences
Lesson Duration: 50 minutes (with 10 and 25 minute extensions)

OBJECTIVES

- Students will explore technologies that are used on farms to increase efficiency and yields and decrease costs and environmental impact, especially how technology has affected farms over time.
- Students will analyze how human and environmental factors influence sustainability in agriculture and make plans for an advocacy project that will improve agricultural and/or environmental systems in a way that is meaningful for them and/or their school community related to how food is grown, harvested, and used globally.

Food Education Standards:	**Content Area Standards:**	**This lesson also aligns to:**
FES3: Food and the environment are interconnected.	NGSS MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	WIDA Standard 1 - Language for Social and Instructional Purposes WIDA Standard 4 - Language for Science

LESSON SYNOPSIS

Students will explore and discuss how technology has changed over time to help farmers/ranchers provide more food to more people, identify specific technologies that have reduced labor in agriculture, and provide examples of science and technology used in agricultural systems (e.g., GPS, artificial insemination, biotechnology, soil testing, ethanol production, etc.); explain how they meet our basic needs, and detail their social, economic, and environmental impacts.

LESSON PREPARATION

Prep Steps	Materials
• Review the lesson and make adjustments as needed for your class. Pre-assign partners/groups (if desired, random works too).	• Three different types of tomatoes (see the activity). Two medium/large and one small. • Computer with internet connection and projector • 1:1 student devices (optional) • Teacher and Student docs (linked below)

VOCABULARY

- Autonomous vehicle [aw-**ton**-*uh*-m*uh*s **vee**-i-k*uh*l] (noun) - a vehicle that can guide itself without a human operator
- Drone [drohn] (noun) : an unmanned aircraft guided by remote control or onboard computers
- Global Positioning System (GPS) [**glo**h-b*uh*l p*uh*-**zish**-*uh*ning **sis**-t*uh*m] (noun) - a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth
- Laser [**ley**-zer] (noun) - a device that produces a narrow and powerful beam of light
- Precision agriculture [pri-**sizh**-*uh*n **ag**-ri-kuhl-cher] (noun) - 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
- Robot [**roh**-bot] (noun) - a mechanical device that is capable of performing a variety of tasks on command or according to instructions
- Self-driving tractor [self **drahy**-ving **trak**-ter](noun) - autonomous farm vehicle that uses GPS and other wireless technologies to farm land
- Sensor [**sen**-sawr, -ser] (noun) - a device that detects or measures a physical property and records, indicates, or otherwise responds to it
- Variable rate application [**vair**-ee-*uh*-b*uh*l reyt ap-li-**key**-sh*uh*n] (noun) - 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.

LESSON ACTIVITIES

Teacher note: These learning tasks and videos are available online for students with access to 1:1 technology, but they should use headphones when watching videos. If your students do not have access to technology, or you don't want them online, feel free to print off the documents. If students are working online. With all documents, please make a copy, do not request access.

This lesson was adapted from adapted from https://agclassroom.org/matrix/lesson/691/

Engage (15 minutes)

1. **(5 minutes)** Think about the ingredients that went into the ham sandwich. What were they again? Ham, cheese, bread, tomato, lettuce, pickle, onion, and wheat. We remember that cheese came from milk and that milk, as the students know, comes from cows. There are other animals we raise for milk as well (such as goats), but cows are the most common.
2. Show the Milking at the 1850 Farm video to see how cows were milked in 1850.
3. Ask the students, "What tools did the pioneer girl in the video use to milk the cow?" (*She used a stool and a bucket.*)
4. Show the students the Robot Milkers video to see how Automatic Milking Systems in modern dairies use robots to milk cows.Ask the students, "What tools were used in the modern dairy to milk the cows?" (*Robotic milking system, digital responders, lasers, and computers.*)
5. Explain the following points into the discussion:
   - Cows are milked two to three times a day.
   - On average, cows produce about seven gallons of milk each day.
   - It takes about fifteen minutes to milk a cow by hand and about five minutes to milk a cow using a robotic milking system.
6. Ask the students, "How does technology impact farms?"

Agricultural Technology Timeline - 10 minutes

1. Share the following about the development of agricultural technology and write on an anchor chart and/or the board. Remind students about the 4 pillars of agriculture and discuss how technology has shifted practices.
   - Agriculture began around 10,000 BC when humans started domesticating plants and animals to ensure a more reliable food source when compared to hunting and gathering. At that time, most work was accomplished by hand with few tools available.
   - The introduction of powered machinery replaced work previously performed by people and animals (horses, mules, and oxen).

- Throughout history, scientific and technological advancements have impacted the agricultural industry by increasing food production and farm efficiency.

2. Organize the students into small groups. Provide each group with a set of Agricultural Technology Timeline Cards.
3. Have each group create a timeline of agricultural technology by ordering the cards and placing the year card in the space provided on the corresponding technology card.
4. After the groups have completed their timelines, check to make sure the order is correct.

Agricultural Timeline (answers)

- **1701:** Jethro Tull introduced the seed drill, a device that cuts trenches and drops in seeds.
- **1793:** Eli Whitney invented the cotton gin, a machine that separates seeds from fiber.
- **1834:** Cyrus McCormick patented the McCormick reaper, a grain harvesting machine.
- **1837:** John Deere invented the steel plow, which was stronger, sharper, and more efficient.
- **1842:** Joseph Dart invented and built the first grain elevator, a wooden structure with buckets used to load and unload ships.
- **1873:** Silos, structures that store grain, came into use.
- **1874:** Glidden barbed wire, an inexpensive fencing used for livestock on rangeland, was patented.
- **1884:** The horse-drawn combine, used to harvest wheat, came into use on West Coast farms.
- **1892:** The first gasoline tractor was built by John Froelich.
- **1959:** The mechanical tomato harvester, used to harvest, sort, and load tomatoes, was developed.
- **1980:** Farmers began using computers to manage farm operations and monitor weather conditions.
- **1992:** The first automatic milking system was installed on dairy farms in the Netherlands.
- **1994:** Farmers began using satellite technology to track and plan their farming practices.
- **2003:** Farm equipment manufacturers install GPS systems in tractors.
- **2012:** The first self-driving, autonomous tractor was unveiled at the Big Iron Farm Show in North Dakota.
- **2015:** Software, mobile devices, and data revolutionize farming potential.
- **2016:** Widespread use of drone technology by farmers.
- **Today:** Harvesting equipment becomes even more specialized.

Lesson Activities - Farm Scenarios 15 minutes

1. Watch the Technology on the Farm video [3:20] to discover how farming technology has changed over time.
2. Arrange students into groups of 4-5. Give each group one of the Farming Challenges cards so that at least two different groups have the same scenario. Explain that each of these cards is a REAL threat that can affect the crops//livestock that farmers raise. Also pass out the *Background Agricultural Connections* reading, which proposes real technological solutions to the problems. Ask the groups to work as agricultural engineers to propose a solution for their challenge. Invite each group to share their challenge and their solutions.
3. Discuss the proposals, pointing out that there can be more than one solution to a problem, and that, typically, an idea must be tested and revised several times before it is successful. Even when ideas are not successful, much can be learned from the process. Use the following questions to guide the discussion:
   - How were the different solution proposals for the same challenge similar or different?
   - What are the pros and cons of the proposed solutions
   - What type of technology (robots, drones, lasers, etc.) were utilized in the proposed solutions?

Elaborate

- How will technology change farming in the future? See one version of how farmers might control their operations in the future by viewing the video Farm Forward. Have the students create a picture that illustrates their version of how farmers will operate in the future.
- View the 15 Modern Agricultural Machines That are at Another Level video. From huge harvesters to entirely new processes, explore some of the latest developments in agricultural machines.

Evaluate

After conducting these activities, review and summarize the following key concepts:

- As the world population increases, farmers need to produce more food.
- The increase in U.S. food production is directly related to the advancement of technology.
- Farmers, scientists, and engineers work to find solutions to agricultural challenges.

CONSIDERATIONS (What adaptations are needed for diverse learners and/or varying dietary needs?)

- Some students may be allergic or not like one/all of the food. Do not force anyone to eat the food, rather, engage students in an empathetic way, validating their concerns and use the opportunity to discuss different diets around the world, in the USA, and in the school community.
- Diverse readings, videos, and visuals were provided, but some students may need support in applying their learning. Support as needed.
- Make sure students have access to language support such as Google Translate.

STUDENT SHEETS AND ASSESSMENTS

- Exit ticket available at the end of the student sheets on the next pages

EXTENSION IDEAS

20 minutes - Technological Tomatoes (adapted from https://cdn.agclassroom.org/ca/resources/lesson/whered.pdf)

1. Make several copies of the tomato fact sheets. Gather the art supplies you would like your students to use for the development of their visual aids.
2. As a class, read and discuss the *Catch Up on Tomato History* reading. You may do this in any way you see fit (shared reading, small groups, jigsaw, independent, popcorn read, etc.)
3. Divide the class into small groups. Give each group the *Tomato Background Information*. Have the student groups read and discuss the information.
4. After making sure that each group understands the facts and focus about tomatoes, distribute the *One Tomato To Rule Them All* to each student, as well as three tomatoes (see activity 1 for more details)

Activity 1: One Tomato To Rule Them All - Tomato Genetics - Making them Different

- Give each student the following:
  - one copy of One Tomato To Rule Them All.
  - 1 paper plate (this will be the cutting board as well as an area to keep the tomatoes)
  - 1 medium or large tomato (we suggest vine grown)
  - 1 medium or large tomato DIFFERENT than the first one
  - 1 cherry or grape tomato
  - 1 knife (or pre-slice the tomatoes)
- Have students draw a line down the center of their paper plate and label each side with the type of tomato; they will look similar, so it will be important to avoid confusing the two.

- Have students complete "Part 1" and "Part 2" of the worksheet and then stop.
- Check in with students and ensure that they're all on the right track.
- Pass out the cherry/grape tomatoes and have students complete “Part 3” and “Part 4”
- Summarize with students by connecting what they know about agricultural technology with what they have learned about how it affects to food we eat, like tomatoes:
  - Genes determine genetic traits found in tomatoes such as size, color, taste, and texture.
  - To develop a new, improved variety of tomato, breeders cross pollinate varieties. This form of sexual reproduction results in an offspring (seed) that is genetically different from the parent plants.
  - Scientists use a knowledge of genetics and heredity to cross breed tomatoes and produce new varieties..

REFLECTION AND NEXT STEPS

Activities that worked	Topics to revisit	Community extension opportunities

Name ________________________ Class _______________________ Date _______________________

STUDENT SHEET: The Four Pillars of AgEd & Advocacy

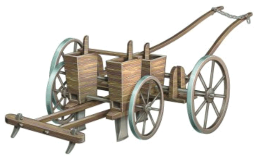
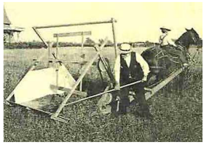
The Four Pillars of AgEd & Advocacy

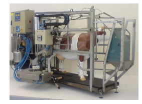
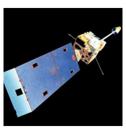
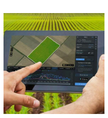
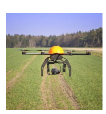
Each pillar becomes dynamic and fully alive through advocacy. *The future of agriculture needs the ideas, actions, and experiences of young people.*			
Food Education	**Growth for All**	**Environmental Action**	**Common Ground**
Agriculture is a defining facet of our food systems; it promotes informed decision making for healthy futures.	Agriculture is a changing industry ripe for innovation with a wide range of careers that provide economic pathways for individuals and communities.	Agriculture is both a cause and a solution for climate change that requires social, scientific, and community driven action.	Agriculture is an entry point for thinkers of all backgrounds to come together and bridge urban & rural divides.

This lesson mostly approached Food Education, Growth for All, and Common Ground.. What challenges or issues exist within agriculture that we are interested in exploring?

Name ______________________ Class ______________________ Date ______________________

STUDENT SHEET: Lesson 4 - Agricultural Technology Timeline Cards.

 Jethro Tull introduced the seed drill, a device that cuts trenches and drops in seeds.	 Eli Whitney invented the cotton gin, a machine that separates seeds from fiber.	 Cyrus McCormick patented the McCormick reaper, a grain harvesting machine.
 John Deere invented the steel plow. It was stronger, sharper, and better than wood or iron plows.	 Joseph Dart invented and built the first grain elevator, a wooden structure with buckets used to load and unload ships.	 Silos, structures that store grain, came into use.
 Barbed wire, an inexpensive fencing used for livestock on rangeland, was patented.	 The horse-drawn combine, used to harvest wheat, came into use on West Coast farms.	 The first gasoline tractor was built by John Froelich.

 The mechanical tomato harvester, used to harvest, sort, and load tomatoes, was developed.	 Farmers began using computers to manage farm operations and monitor weather conditions.	 The first commercial automatic milking system was installed on dairy farms in the Netherlands.
 Farmers begin using satellite technology to track and plan their farming practices.	 Farm equipment manufacturers install GPS systems in tractors.	 The first self-driving, autonomous tractor was unveiled at the Big Iron Farm Show in North Dakota.
 Software, mobile devices, and data revolutionize farming potential.	 Widespread use of drone technology by farmers.	 Harvesting equipment becomes even more specialized.

1701	1793	1834
1837	1842	1873
1874	1884	1892
1959	1980	1992
1994	2003	2012
2015	2016	Today

Name ________________________ Class ______________________ Date ______________________

STUDENT SHEET: Lesson 4 - Tomato Background Information

It is agriculture's quest to grow more and better crops using fewer resources. Many factors affect the production of a crop. Selective breeding, genetic engineering, and better farming practices have enabled tomato growers to produce crops that are more plentiful, safer for the environment, more nutritious, and better tasting.

Natural selection is the process of having certain traits selected and expressed over time. In natural selection, the traits that are passed on from one generation to the next have to do with environmental conditions and other natural processes. One of the most noted studies of natural selection is Charles Darwin's study of the finches on the Galapagos Islands.

Selective breeding is the process of purposely crossing two plants, animals, bacteria, yeasts, or viruses with desired traits to produce offspring with those desired traits. For example, a tomato plant that produces large tomatoes might be crossed with a tomato plant that produces sweet tomatoes in order to produce large, sweet tasting tomatoes. Selective breeding practices have occurred for a very long time. The book *Corn is Maize* by Aliki (see page 67) describes the selective breeding that occurred to produce the sweet corn we eat today.

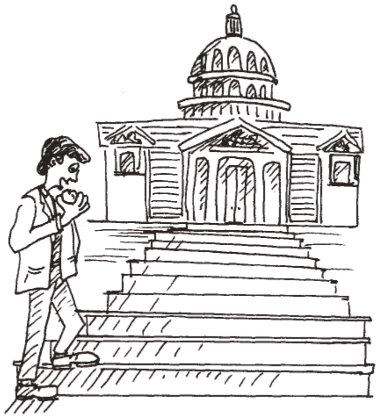
Genetic engineering is a process where genetic material (DNA) is taken from one organism and inserted into the genetic code of another organism. This science has progressed because scientists now know that a gene for a certain trait is a universal gene. That is to say, a gene for the color red in bacteria can also produce a red color in other species of living organisms. The MacGregor tomato was created by using bacterial genes to manipulate a tomato gene which causes softening in tomatoes. Using advanced scientific techniques, the gene for ripening is removed from the tomato DNA and reinserted backwards rendering it inactive. Genetic engineering processes are very complex and can be studied by students when they take advanced science courses in high school.

You and your students will take a closer look at the history of the tomato and observe how various scientific techniques have produced the fresh market and processing tomatoes farmers grow today. Many social issues related to technological advances can be discussed throughout this activity.

Name______________________________Class_________________________Date______________

Catch Up On Technical Tomato History

People used to think tomatoes were poisonous and for years no one ate them. Tomatoes first grew as wild, cherry-sized berries in the South American Andes, but the tomatoes we eat today were developed in Mexico. Tomatoes are known as a "tomatils" in Mexico. People kept pollinating the large sized cherry tomato flowers with other large sized cherry tomato flowers so the fruit would be larger. This process is called selective breeding.



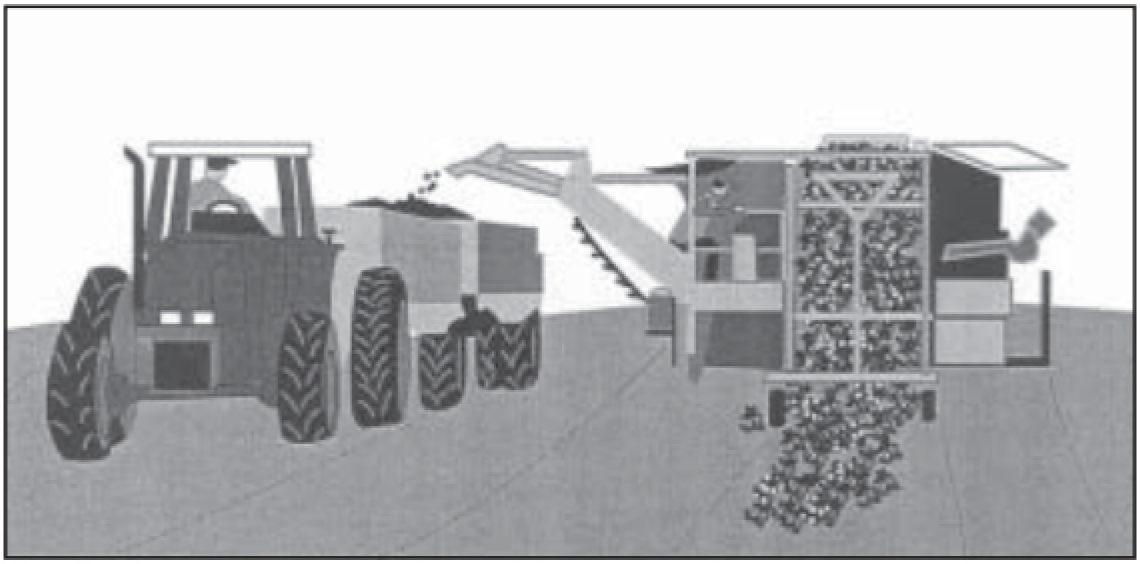
The tomato traveled to Europe and returned to the Americas with the Conquistadors. In Italy, the tomato appeared heart-shaped and was called *poma amoris*, which means "love apple."

The American colonists believed that since the tomatoes were related to the deadly nightshade plant and that they were poisonous, so they avoided eating them. In 1820, Robert Gibbon Johnson bravely stood on the New Jersey courthouse steps and ate a tomato! He never got sick and lived to the age of 79. Since then, the tomato has become increasingly popular, not only as a fresh product in salads but in many ethnic food dishes. Italian and Mexican cuisine feature tomato recipes including salsa, pasta, and tortilla sauces.

Most tomatoes Americans eat are grown in California, Florida, and Mexico. Ninety-five percent of the processing tomatoes and about 75 percent of all tomatoes grown in the United States are grown in California. In 2000, California harvested 10.2 million tons of processing tomatoes—over 290,000 acres of California land was planted with tomatoes. California is now the nation's tomato capital.

Many major changes have been made in the tomato plant during the last 40 years. Some of these improvements have been made through genetic engineering—where a gene from one organism is inserted into another organism or where an identified tomato gene is reversed and reinserted. Others have been made by selectively breeding tomato plants that have desired traits. With increasing farm costs, a reduction in available land to farm, and a continuing increase in human population, farmers are always concerned on how much food they can produce on a certain plot of land. The amount they produce is called their yield. One way tomato yields have increased is through the injection of a gene in tomatoes which produces "uniform ripening." This eliminates a dark green "shoulder" that sometimes appears on tomatoes. It also makes all of the tomatoes on the vine ripen at one time. This makes it easier for pickers since they only have to go into the fields once rather than several times. Since less labor is involved, the price of the fresh market tomatoes can be cheaper.

Another development is the introduction of a gene which causes the tomato plant to "self prune." This means the tomato plant does not grow too bushy and widespread. The branches of this special tomato plant only grow a certain length. The result is a plant that is easier to harvest by machine.



Many tomatoes today are picked by mechanical harvesters. Not only has genetic engineering helped in the harvesting of tomatoes, but advances in the technology used on harvesters have helped as well. Tomato breeders wanted a small, compact plant with tomatoes whose shape and skin texture could handle machine picking. After years of diligent breeding, a tomato that was "square round" was developed. It had a shape that could be picked by machine and a tough skin. Machine harvesting meant farmers saved the cost of expensive hand labor to pick tomatoes and the fruit could be harvested quickly.

Tomato breeders have also produced a wide range of tomato varieties through selective breeding. One variety of tomato has a small amount of juice, has good peel ability, and the ability to hold up after being diced. These meaty tomatoes are used to make tomato paste. This tomato paste is either sold in stores as tomato paste or is reconstituted (water added back into it) to produce tomato sauces and catsup during the off season. This makes tomato products available year-round. Another variety of tomato is easy to peel and has a little more juice than other varieties. This type of tomato is used to make tomato juice and tomato sauce right after harvest.

Another feature that has been selectively bred into tomatoes is the size of the stem scar—the part of the tomato where it attaches to the stem. A smaller stem scar makes the tomatoes easier to harvest and also provides a better product. It may not seem that a 1/4" reduction in stem scar size could increase the amount of tomato paste produced by a tomato, but imagine if millions of tomatoes had a smaller stem scar (like a truck load full). Then the stem scar size does make a difference!

Information obtained from Dona Mast, a tomato grower in Esparto, California, and Andy Kennedy, a tomato field representative and buyer for the Colusa County Canning Company in Williams, California and *Blue Corn and Square Tomatoes* by Rebecca Rupp; Story Communications, Inc., 1987

One Tomato To Rule Them All...

Name______________________________Class__________________________Date________

Part 1: Comparing 'big' tomatoes

	Tomato 1 -	**Tomato 2 -**
Look	Explain what you observe on the outside and inside of this particular tomato. Write down what you notice, stem structure, seed layout, and coloring.	
Outside of Tomato		
Inside of Tomato		
Smell	Explain what you observe using your sense of smell.	
Outside of Tomato		
Inside of Tomato		
Touch	Explain what you observe about the texture of the Tomato. (skin, meat, seed, stem)	
Outside of Tomato (Texture)		
Inside of Tomato (Number of seeds and seed shape)		
Taste	Explain what you observe when you taste your Tomato.	
Tartness		
Sweetness		
Juiciness		
Crunchiness		

Part 2: Analyzing the Data:

1. Explain what similarities you found between the tomatoes.
2. Explain what differences you found between the tomatoes.

Part 3: Cherry Tomato Observation: Observe and record traits of Cherry Tomatoes.

Cherry Tomato Observations	
Look	Explain what you observe on the outside and inside of this particular tomato. Write down everything you notice, stem structure, seed layout, and coloring.
Outside of Tomato	
Inside of Tomato	
Smell	Explain what you observe using your sense of smell.
Outside of Tomato	
Inside of Tomato	
Touch	Explain what you observe about the texture of the tomato. (skin, meat, seed, stem)
Outside of Tomato	
Inside of Tomato	
Taste	Explain what you observe when you taste your Tomato.
Tartness	
Sweetness	
Juiciness	
Crunchiness	

Part 4: Similarities and differences found:

1. Describe similarities you found among all 3 tomato varieties.

2. Describe differences you found among all 3 tomato varieties.

Crossbreeding Tomatoes

1. Which of the three tomatoes was your favorite? Why?

2. Why do tomato breeders crossbreed tomato varieties?

Name____________________________Class_________________________Date_________________________

Background Agricultural Connections

In the 1940s, one farmer in the United States produced enough food to feed 19 people. Today, one US farmer produces enough to feed 172 people. The increase in U.S. food production is directly related to the advancement of agricultural technology.The Food and Agriculture Organization (FAO) of the United Nations (UN) projects the world population to reach 9.7 billion people by the year 2050. With 9.7 billion people on Earth, the world's farmers will need to grow about 60-70 percent more food than what is now being produced. As the global production increases, farmers will need to utilize innovative technologies to produce more food with fewer resources.

Did You Know?

- In 1850, 100 bushels of corn required 83 labor hours and 2.5 acres of land. Today, only two labor hours and .6 of an acre of land are needed.
- A modern combine can harvest 350 acres of corn per day (4,500 bushels per hour) and it can unload 3.8 bushels per second.
- If the world's farmers would have continued to grow crops at 1961 productivity levels, they would need almost 2.5 billion acres of new farmland to maintain today's food supply, which is more than the total land area of the United States.

Precision agriculture is 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. Precision agriculture technologies help farmers identify and manage variability within fields and can optimize crop yields, maximize crop quality, and minimize the use of resources. Rather than apply water, fertilizer, and pesticides uniformly across entire fields, farmers can use data to target specific areas within the minimum quantities required. More efficient food production means lower costs to consumers, greater consumer choice, convenience, safer food, and greater food security. Precision farming began in the 1990s when

Global Positioning System (GPS) technology became available to the public. GPS uses satellites and computers to determine positions on Earth. GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, **variable rate applications**, and yield mapping.

Agricultural robots automate repetitive farming tasks. Robots are used for harvesting, weed control, mowing, pruning, seeding, spraying, sorting, and packing. Robots can be seen as a solution to food production labor shortages. There are jobs on the farm that do not create value at or above minimum wage. By automating sub-minimum wage jobs, more food can be produced at a lower cost.

Drone applications in agriculture include mapping, surveying, monitoring, planting, crop dusting, and spraying. Precise soil analysis maps produced by drones help direct seed planting patterns, irrigation, and nitrogen-level management. Nutrients, moisture levels, and overall crop health is monitored in real-time by drones equipped with hyper-spectral, multispectral, and thermal **sensors**. Scanning crops with visible and infrared (IR) light, drones can identify plants infected by bacteria or fungus, helping to prevent disease from spreading to other crops. This technology enables detection of some diseases before they are visible to the human eye.

Advanced **laser** technology is used on farms to deter birds, level fields, guide harvesting machines, sort agricultural products, and monitor field conditions. Birds are naturally drawn to food growing in fields and can transmit diseases and damage crops. Laser beams are used to repel birds in a safe, silent manner that the birds do not become used to. Laser leveling can enhance productivity on uneven fields by improving drainage and decreasing water usage. In the laser leveling process, a tower mounted laser level is used in combination with a sensor on a tractor-scraper. Machines used to pick vegetation from fields can be guided using laser rangefinders which instantaneously communicate the height of the vegetation relative to the ground. Lasers are also used to sort agricultural products by identifying items that do not meet optimal specifications. Used in combination with sprayers, lasers can monitor for specific field conditions to ensure that only the necessary amount of chemical is applied to each specific area of the field.

Biotechnology includes a number of technologies, which use living organisms (such as microbes, plants, fungi, or animals), to produce useful products, processes, and services. Production can be carried out by microorganisms such as yeast or bacteria or by chemicals produced from organisms, such as enzymes. The use of yeast in bread making is a form of biotechnology. The use of bacteria and molds in cheeseñ making is another example of simple biotechnology. In the 1970s, a new type of biotechnology was developed: genetic engineering, also known as recombinant DNA technology or transgenics. What is genetic engineering?

Genetic engineering is a process in which genetic material (DNA) is taken from one organism and inserted into the cells of another organism, often of a different species. Genetic engineering can also be a rearrangement of the location of genes. The new ìalteredî organism then makes new substances or performs new functions based on its new DNA. For example, the protein insulin, used in the treatment of diabetes, can now be produced in large quantities in a laboratory by genetically modified bacteria and yeast. Insulin was formerly extracted from the pancreas of pigs. What can genetic engineering do? It can improve the ability of an organism to do something it already does. For example, an adjustment in the amino acid balance in a particular corn variety improves its storage ability. A genetically enhanced rice variety is resistant to bacterial blight due to the insertion of an Xa21 gene that increases its resistance to the disease-causing microbes. It can also suppress or stop an organism from doing something it already does. For example, the gene that codes for the softening of tomatoes is ìturned-offî in a genetically modified tomato variety. This allows the tomato to stay on the vine longer, producing more flavorful fruit that is firm enough to easily transport.

Name ________________________ Class ______________________ Date ______________________

STUDENT SHEET: Lesson 4 - Technological Solutions to Agricultural Problems

Using information from the video and reading, propose a solution to your agricultural problem. You may write or draw, but you should support your thinking with evidence to justify your decisions.

My agricultural problem____

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Proposed Solution: