LESSON OBJECTIVE
- Students will study how technology, biology, and ecology all play a role in farming in America

GRADE
- 6

STANDARDS
- Social Studies

TIME REQUIRED
- 45-60 min

VOCABULARY
- Natural selection
- Selective breeding
- Genetic engineering
- Sustainable agriculture

MATERIALS
- Web access to watch short video

RECOMMENDED ASSESSMENT
- Student handout

Introduction
Students will study how scientific advances have helped improve agricultural processes and how these advances in agricultural practices contribute to the health of our environment. They will then brainstorm ideas on steps they can take to help conserve resources and make a positive impact on the environment.

State Standards
6.3.13 Impact of humans on the environment in the Americas

Lesson Plan
Background Knowledge –
- *Natural Selection:* the process by which organisms better adapted to their environment tend to survive and produce more offspring.

- *Selective Breeding:* the process of choosing parents with particular characteristics to breed together and produce offspring with more desirable traits.

- *Genetic Engineering:* the deliberate modification of the characteristics of an organism by manipulating its genetic material.

- *Sustainable Agriculture:* farming in such a way to protect the environment, aid and expand natural resources, and make the best use of nonrenewable resources.

Activity –
1. Ask students for examples of occupations that use technology. They will probably offer answers such as engineering, computer programming, or other office jobs. Tell students that many other traditional careers have been changed greatly by technology and today we are going to look at how technology has impacted farming.

2. Have students read through the first activity introduction and watch the video. Then, answer questions 1-3 on the handout.

3. Discuss with the students how species evolve over time through natural selection. Organisms with genetic mutations that help them adapt to their environment are the ones most likely to reproduce and pass their beneficial genes on to their offspring. Today, farmers can use this science to genetically engineer natural selection.

4. Have student complete the chart comparing and contrasting selective breeding and genetic engineering, found on page two of the handout.

5. Tell students to read about the sustainable agriculture practices in the first column on the last page and decide if that practice helps conserve energy, conserve water, minimize pollution, or build soil health.

6. Answer key: A:all 4; B: energy, waste, soil; C: water, waste, soil; D: energy, waste; E: energy, waste; F: waste

Post Activity –
The Zoo's Green Practices Committee works to limit the impact of the zoo on the environment by implementing recycling programs, switching to sustainable products, and conserving water and energy use. Small changes in our personal lives can have a BIG impact on the environment. Check out National Geographic Kids' Guide on How to Save the Planet for ways for your students to do their part, too:
https://www.natgeokids.com/uk/discover/science/nature/how-to-save-the-planet/

Discover Further

Extending the Lesson –
Have students create a proposal for a new farm robot that will perform a specific task in order to help the farmers save time or resources.

Have students write an action plan of one environmental step they will take. For example, students could write, "I will commit to turning off the water while I brush my teeth to save water."

Learn More –
American Dairy Association: AmericanDairy.com
USDA's website on Sustainable Agriculture: https://www.nal.usda.gov/farms-and-agricultural-production-systems/sustainable-agriculture

Farm Science

Name: _____ Date: _____

Today's farmers use satellite technologies like GPS (Global Positioning System) and GIS (Geographic Information System) to get information about soil, crops, and livestock. Instead of treating the whole crop for pesticides, the data might tell the farmer which parts need treatment, saving time and money and helping to protect the environment. Today's farmers also use sensors to collect data on weather and soil health, letting them know how much fertilizer to add to different regions of their fields. Some farmers even use robots to plow fields, plant seeds, weed, irrigate, and harvest the crops.

The science of robotics is modernizing dairy farms. Watch the video Robot Milk: How Intelligent Machines are Revolutionising Cow Farming by BBC Earth Lab at https://www.youtube.com/watch?v=tLjI_eixBQk.

1. How do Global Positioning Systems and Geographic Information Systems help farmers?

2. How do robotic milking machines benefit the cows AND the farmers on a dairy farm?

3. In a small group, brainstorm ways robotics might be used in other types of farming. What is one specific farming task that a robot could be made to do?

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Farmers have used selective breeding to create new kinds of food. Ancient wheat farmers would select plants with larger kernels of grain and seed for their next crop. Farmers can also use cross breeding – mating organisms that display a desired characteristic – to create a new hybrid, such as seedless watermelon. Scientists have created crops that are unharmed by pesticides that kill weeds, allowing farmers to use fewer pesticides: in fact, studies show that genetic engineering has reduced farm use of chemical pesticides by 37% nationwide. Genetic engineering crops also improves farmers' ability to conserve soil and water.

Animals and plants created through genetic engineering are sometimes called GMO's: genetically modified organisms. While some people worry about the unknown consequences of GMO's, the benefits are improving agriculture around the world.

4. The chart below compares selective breeding and genetic engineering. Discuss the chart in your groups and then use the space below to compare and contrast both methods.

Selective Breeding	Genetic Engineering
Choose parents with traits you want and these traits will be passed on to the offspring.	Add the gene for the trait you want into the DNA of the organism so it can be passed on the offspring.
Examples	**Examples**
• Disease-resistant wheat is created by breeding hardy wheat plants that have a high yield.	• Scientists have created pesticide-resistant soybeans by adding a bacteria gene to soybean DNA.
• Milk protein is improved by breeding dairy cows to bulls that have high levels of protein production.	• Scientists have created a salmon that grows faster while eating less food by adding a gene from Chinook Salmon to Atlantic Salmon DNA. The result is the first genetically engineered animal food product, currently available in Canada.
• Hardy snacking apples are created when a sweet variety of apple is grafted onto the truck of a fungus-resistant variety. This gives the benefit of higher-producing sweet apple trees that are fungus-resistant.	• When scientists added the genes that produce Vitamin A in carrots to white rice DNA, they created "golden rice" – a food rich in Vitamin A for countries where Vitamin A deficiency causes childhood blindness.
Similarities:	
Differences:	

Technology and bioscience help farmers produce better crops, but without a healthy growing environment, those crops will fail. Farmers use sustainable agricultural practices to protect and nurture the environment. These practices help conserve energy and water, minimize pollution, and build soil health.

5. For each practice listed below, decide if that practice helps conserve energy, conserve water, reduce pollution, or build soil health by putting an "X" in the correct box. Some may have more than one box checked. Then, fill in a way you can help achieve those same environmental goals at home.

Sustainable Farming Practice	Conserves Energy	Conserves Water	Reduces Waste and Pollution	Builds Soil Health	What I Can Do
A. Cow manure is used in place of commercial fertilizer to improve soil quality.					
B. Methane digesters use the gas given off by cow manure as fuel to generate electricity.					
C. Natural groundcover along stream banks reduces runoff from fields into the stream.					
D. Solar panels on barn roofs generate electricity for use on the farm.					
E. Shredded wastepaper and peanut shells are recycled to provide bedding for the cows.					
F. Orange peels, cotton seeds, and other leftovers are mixed with grain to provide nutritious cow feed.					

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