



# SCIENCE ON THE FARM

## TARGET AUDIENCE

Middle school students in science and environmental science classes

## PROGRAM OBJECTIVES

- Educate students about scientific technologies used in 21st century farming
- Explore environmentally beneficial techniques used in modern agriculture
- Raise awareness of principles farmers use to make sure cows are well cared for
- Examine efforts to make food more nutritious

## PROGRAM COMPONENTS

- This teacher's guide
- Three student activity sheets that align with NGSS and CCSS ELA standards
- A reply card for your feedback, or comment online at [ymiclassroom.com/feedback-farmscience](http://ymiclassroom.com/feedback-farmscience)
- Access to Interactive Virtual Farm Tours at [www.american-dairy.com/dairy-farms/virtual-farm-tours/](http://american-dairy.com/dairy-farms/virtual-farm-tours/)
- Microsite with downloadable standards chart, answer keys, and more materials and ideas at [ymiclassroom.com/farmscience](http://ymiclassroom.com/farmscience)



### Farm Technology

Ask students to think about ways they use technology to make work easier or to live more comfortably. Their examples may include computers, Bluetooth, and GPS maps. Tell students that technology is also used on farms to help produce the food we eat.

Have students read the activity introduction, and discuss how it may have changed their ideas about what it means to be a farmer. Then have students go to [https://www.youtube.com/watch?v=\\_4IlgABMM&t=9s](https://www.youtube.com/watch?v=_4IlgABMM&t=9s) to watch a video of Farmer Jared Kurtz of Kurtland Farms about how robotics have improved cow care and milk production at a Pennsylvania dairy farm. Afterwards, have students respond to the focus questions in writing or in a class discussion.

For Part 2, view the video about harvesting technology at <https://youtu.be/kj6XtYvszEU>. Then, divide students into groups and assign each team one of the technologies mentioned: drones, GPS, GIS, robots. Provide time for research, then bring the groups together to share what they learned.



### Farm Biology

This activity explores how advances in bioscience have helped improve farming practices and provide a scientific perspective on the GMO debate. Begin by discussing how species evolve through natural selection. Organisms with genetic mutations that help them adapt to their environment are most likely to reproduce and pass their beneficial genes on to their offspring.

Remind students that farms are the original biotech labs. It was experiments with selective breeding of pea plants that led Gregor Mendel to discover the underlying rules of genetics.

Explain how farmers have used selective breeding to create new kinds of food. Ancient wheat farmers, for example, would select plants with larger kernels

of grain as seed for their next crop. Farmers have also used cross breeding — mating organisms that display a desired genetic characteristic to create a new hybrid, such as seedless watermelon.<sup>1</sup>

Since the 1990s, genetic engineering has provided another way to improve crop yield and quality. By adding a new gene to a plant's DNA, scientists have created crops that can resist insect pests and weeds without being harmful to humans. This genetic engineering has allowed farms to reduce herbicide and pesticide use, thereby reducing impacts on the environment.<sup>2</sup>

Animals and plants created through genetic engineering are sometimes called GMOs — genetically modified organisms. Some people worry that GMOs have unknown consequences. However, the benefits of GMOs are improving agriculture around the world.<sup>3</sup> Golden rice, for example, has the potential to prevent blindness in children. Genetically engineered crops can also help conserve soil and water. The cost savings help make nutritious foods more affordable for consumers.

Have each student compare genetic engineering with selective breeding by weighing the pros and cons of each method based on the examples provided. Then ask them to write a paragraph explaining the subsequent nutritional benefits to families.



### Farm Ecology

Advances in technology and bioscience help farmers produce better crops, but without a healthy growing environment, those crops are doomed to fail. Explain to students that farmers use practices that protect and nurture the environment. This is called *sustainable agriculture*. These practices help conserve energy and water, minimize pollution, and build soil health.

Tell the students to read about the sustainable agriculture practices in the first column on the activity sheet, and then decide if that practice helps conserve energy, conserve water, minimize pollution, and/or build soil health. Then ask students to think of a way they can help achieve the same environmental goals at home.

**Answers:** 1: A, B, C, D; 2: C; 3: A, B, C; 4: B, C, D; 5: C; 6: A, C; 7: C. For more detailed information, download the Answer Key at [ymiclassroom.com/pdf/fs\\_answerkey.pdf](http://ymiclassroom.com/pdf/fs_answerkey.pdf).

## Resources

- Virtual Dairy Farm Tours** [AmericanDairy.com/dairy-in-schools/virtual-farm-tour.shtml](http://american-dairy.com/dairy-in-schools/virtual-farm-tour.shtml)
- American Dairy Association North East** [AmericanDairy.com](http://AmericanDairy.com)
- Young Minds Inspired** [ymiclassroom.com/farmscience](http://ymiclassroom.com/farmscience)
- “Apple Breeding, Genetics and Genomics”** <http://nyshs.org/wp-content/uploads/2015/10/Brown-Pages-from-NYFQ-Book-Fall-2015.pdf>
- Agricultural Biotechnology** [https://www.fda.gov/food/consumers/agricultural-biotechnology](http://www.fda.gov/food/consumers/agricultural-biotechnology)



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## DEAR EDUCATOR,

The coronavirus pandemic has thrown a spotlight on the complex process involved in getting food from the farm to our tables. For many people, it has also highlighted the importance of nutrient-dense, affordable, local food sources. These are issues that dairy farmers focus on every day.

Do your students know the role that technology plays on today's dairy farms? Modern farmers use smartphones, GPS, drones, and robots all along the supply chain. Precision farming, coupled with the latest research, allows 21st century dairy farms to improve animal care, sustainability, and nutrition continually.

This teaching kit, developed by curriculum specialists Young Minds Inspired (YMI) in partnership with American Dairy Association North East (ADANE), is designed to help you introduce your students to the important roles that technology and bioscience play in modern farming, and help them understand how these advances in agricultural practices contribute to the health of our environment, our families, and the animals farmers care for.

Please photocopy and share these materials with other teachers in your school. Return the enclosed reply card to let us know your opinion of this program, or comment at [ymiclassroom.com/feedback-farmscience](http://ymiclassroom.com/feedback-farmscience). We look forward to your comments.

Sincerely,



Rick Naczi, CEO  
American Dairy Association  
North East

  
Dr. Dominic Kinsley  
Editor in Chief  
Young Minds Inspired



Questions? Contact us toll-free at 1-800-859-8005 or by e-mail at [feedback@ymiclassroom.com](mailto:feedback@ymiclassroom.com).

1. Learn more about selective breeding of watermelon: <https://www.watermelon.org/the-slice/where-does-seedless-watermelon-come-from/>  
 2. <https://www.tandfonline.com/doi/full/10.1080/21645698.2020.1773198>  
 3. For more on the debate over GMOs, students can watch the film “Food Evolution,” available at <https://foodevolutionmovie.com/>.



# FARM TECHNOLOGY

**Technology has made modern farming more productive.** On dairy farms, it also keeps cows healthier and more comfortable. Jared Kurtz and his family, who own Kurtland Farms in Elverson, Pa., milk cows on their farm using **robots!**



Robotic cow milking at Kurtland Farms

The Kurtz Family, Kurtland Farms, Elverson, Pa.

## Part 1

Robotic milking systems allow cows to choose when they want to be milked and provide farmers with valuable information on the health and habits of each animal. To see how, watch the video of Farmer Jared at [https://www.youtube.com/watch?v=\\_4\\_lIgABMM&t=9s](https://www.youtube.com/watch?v=_4_lIgABMM&t=9s). Think about how robotic milking systems help farmers take better care of their livestock. Then, answer the questions below.

1. How do robotic milking machines benefit farmers? \_\_\_\_\_

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2. What kind of information do the sensors collect about each cow? \_\_\_\_\_

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3. Why do the cows choose to be milked? \_\_\_\_\_

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4. How do robotic milking machines help farmers take better care of each cow? \_\_\_\_\_

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**Part 2** Modern farmers also use other types of technology and data to care for their farms, solve problems, and improve their results. This is a precision farming approach to farm management. For example, some farmers use satellite and sensor technologies like GIS (Geographic Information Systems) to collect information about their soil, crops, livestock, and even the weather. They use GPS (Global Positioning Systems) to map fields, guide tractors, and check crops, even at night. Drones and robots can be used to disperse chemicals, plow fields, plant seeds, weed, irrigate, and harvest the crops. See how Kelsey O'Shea of Maplevue Dairy in Madrid, N.Y., uses harvesting technology in the video at <https://youtu.be/ki6XtYvszEU>. These tools save time and money. For dairy farmers, it means more time spent caring for the cows themselves.



Choose one of the technologies listed in the paragraph above. Research how it is used on modern dairy farms and write down 3-4 benefits it offers to farms, families, animals, and the environment. Write your list on the back of this sheet.



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# FARM BIOLOGY

**Farms are the first biotech labs.** Since ancient times, farmers have used *selective breeding* to make the foods we eat more widely available and nutritious. Today, scientific developments have enabled the transfer of specific genes from one organism to another. This process is called *genetic engineering*.

The chart below shows the impact of selective breeding and genetic engineering on modern farming, including examples that improve our food supply. Discuss the chart with your class and then use the space below and the back of the sheet to compare and contrast the two methods.



Matt Fry of Fair Hill Farms in Chestertown, Md., uses an app to track his cows' genetic history.

## Part 1

Selective Breeding	Genetic Engineering
Choose parents with traits you want. These 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 to the offspring.
Examples	Examples
1. Disease-resistant wheat is created by breeding hardy wheat plants with wheat plants that have a high yield. As a result, families have better access to nutritious grains for a lower cost.	1. Scientists have engineered dairy cows to produce human antibodies for viruses such as influenza and ebola. This could allow for treatment of a large number of people in a short time frame. <sup>1</sup>
2. The amount of protein in milk is improved by breeding dairy cows to bulls that have high levels of protein production.	2. Scientists have created a special type of soybean that produces oil with more "healthy" fat and no trans fat, which can raise cholesterol and increase risk of heart disease.
3. Hardy snacking apples are created when a sweet variety of apple is grafted onto the trunk of a fungus-resistant variety. This gives the benefit of higher-producing sweet apple trees that are fungus-resistant. This means more fruit for more families.	3. 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:	

**Part 2** Dairy farmers use many other types of biotechnology to improve food production. How does biotechnology on dairy farms support people's nutritional needs? Write your answer on the back of this sheet.



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1. <https://www.technologyreview.com/2016/10/04/107551/cows-engineered-with-human-genes-could-stop-our-next-disease-outbreak/>



# FARM ECOLOGY

## Today's dairy farmers use sustainable farming practices

to protect the environment by conserving energy and water, reducing pollution, and building soil health. Soil health refers to the soil's ability to function as an ecosystem that can support plants, animals, and humans.



Look at the chart below. Read about the sustainable farming practices in the first column, and then decide if that practice helps conserve energy, conserve water, reduce waste and pollution, or build soil health by putting an "X" in the correct box. You may mark more than one box for each sustainable practice. Then, fill in a way you can help achieve those same environmental goals at home.

Sustainable Farming Practice	A. Conserves Energy	B. Conserves Water	C. Reduces Waste and Pollution	D. Builds Soil Health	E. What I Can Do
1. Cow manure is used in place of commercial fertilizer to improve soil quality.					
2. Methane digesters use the gas given off by cow manure as fuel to generate electricity.					
3. Some dairy farmers use a device called a plate cooler to cool the milk as it comes from a cow. Cold water passes right from the well through the plate cooler, and absorbs heat from the warm milk. Farmers then re-use this water in different ways: as drinking water for cows (who prefer warm water); to cool the cows with a fine spray when it is hot; to wash farm equipment and clean the barn floor.					
4. Field cover crops keep soil and nutrients in place and reduce runoff.					
5. Solar panels on barn roofs generate electricity for use on the farm.					
6. Recycled materials such as shredded waste paper, dried manure solids, and even sand (which can be reused time and again) are used as bedding for the cows.					
7. Orange peels, cotton seeds, and other leftovers are mixed with grain to provide nutritious cow feed.					



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