



# 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
- Access to Interactive Virtual Farm Tours at [americandairy.com/dairy-farms/virtual-farm-tours/](http://americandairy.com/dairy-farms/virtual-farm-tours/)
- Microsite with standards chart, answer key, bonus activity, supporting resources, and an online feedback form 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://youtu.be/nj\\_h2qX74Ng?t=1372](https://youtu.be/nj_h2qX74Ng?t=1372) to watch a video of Farmer Kelly of Reyncrest Farm about how farmers use pedometers to monitor cows' health at a New York 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 [youtu.be/ki6XtYvszEU](http://youtu.be/ki6XtYvszEU) and the video link on the activity sheet. 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, is a GMO that 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).



### Dairy Ecosystems

This crossword puzzle highlights sustainable practices farmers follow to produce high-quality milk. It can be found at [ymiclassroom.com/farmscience](http://ymiclassroom.com/farmscience). Answers appear on the Answer Key at the link above.

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## Resources

- **Virtual Dairy Farm Tours** [americandairy.com/dairy-farms/virtual-farm-tours](http://americandairy.com/dairy-farms/virtual-farm-tours)
- **American Dairy Association North East** [americandairy.com](http://americandairy.com)
- **Young Minds Inspired** [ymiclassroom.com/farmscience](http://ymiclassroom.com/farmscience)
- **Agricultural Biotechnology** [fda.gov/food/consumers/agricultural-biotechnology](http://fda.gov/food/consumers/agricultural-biotechnology)

## 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,

John Chrisman, CEO  
American Dairy Association  
North East

Dr. Dominic Kinsley  
Editor in Chief  
Young Minds Inspired



Questions? Contact YMI 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/>.



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# FARM TECHNOLOGY

Technology has made modern farming more productive. On dairy farms, it also keeps cows healthier and more comfortable. Aurora Ridge Dairy of Aurora, N.Y., uses collars on their cows to monitor the animals' health in real time, much like a fitness watch!



Aurora Ridge Dairy of Aurora, N.Y., uses collars to monitor their cows' health.

**Part 1** Cow pedometers can be in the form of an ankle bracelet or a neck collar that cows wear all the time, much like a fitness watch. These track each animal's steps as well as other health and habits of the cows. To see more about this, watch the video of Kelly Reynolds at Reyncrest Farm at [youtu.be/nj\\_h2qX74Ng?t=1364](https://youtu.be/nj_h2qX74Ng?t=1364). Think about how cow health monitors help farmers take better care of their cows. Then, answer the questions below.

1. How do cow pedometers or collars (sensors) benefit farmers? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. What information do the sensors collect about each cow? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. Why would a cow's number of daily steps change? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. How would a farmer use the information collected by a sensor? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**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. Check out how Stephen Gould of HaR-Go Farms of Pavillion, NY, uses technology and science to sustainably care for the land they crop to feed their cows at [youtube.com/watch?v=I46TJfSteM0&t=5s](https://youtube.com/watch?v=I46TJfSteM0&t=5s). 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.



Phoebe and Dave Bitler of Vista Grande Farm in Fleetwood, Pa., use an app to track their cows' history and health.

## 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.
<b>Examples</b>	<b>Examples</b>
<p>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.</p> <p>2. By selectively breeding bulls with dairy cows that produce high levels of milk protein, the resulting offspring will likewise produce high-protein milk.</p> <p>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.</p>	<p>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></p> <p>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.</p> <p>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.</p>
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.



Lawnhurst Farms of Stanley, N.Y., use anaerobic digesters to convert methane, a greenhouse gas released from cow manure, into a source of electricity.

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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# DAIRY ECOSYSTEMS

Dairy farmers work hard to produce high-quality milk while protecting the environment.

Refer to the article *Dairy and the Environment*, at [www.americandairy.com/sustainability/dairy-and-the-environment](http://www.americandairy.com/sustainability/dairy-and-the-environment), to complete this crossword puzzle. Next to each clue, write the paragraph number where you found the answer.

1

2

3

4

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19

## ACROSS

9. The natural world around us (paragraph \_\_\_\_)
11. To use less of a resource (paragraph \_\_\_\_)
12. Person who raises livestock or grows crops (paragraph \_\_\_\_)
13. To keep safe (paragraph \_\_\_\_)
14. A greenhouse gas released by cow manure (paragraph \_\_\_\_)
15. Resource used for energy, such as nonrenewable oil or gas (paragraph \_\_\_\_)
18. Describes a system of producing food or products without harming the environment (paragraph \_\_\_\_)

## DOWN

1. The flow of money for farms and their neighbors (paragraph \_\_\_\_)
2. The people who live, work, and share a region (paragraph \_\_\_\_)
3. When soil washes or falls away (paragraph \_\_\_\_)
4. To make something usable again (paragraph \_\_\_\_)
5. A critical natural resource that flows in rivers and streams (paragraph \_\_\_\_)
6. Release of gases into the atmosphere (paragraph \_\_\_\_)
7. Producing more with fewer resources or less waste (paragraph \_\_\_\_)
8. An energy source that can be easily replenished (paragraph \_\_\_\_)
10. A balance between the CO<sub>2</sub> that is released and absorbed (paragraph \_\_\_\_)
12. Used to enrich soil to feed plants (paragraph \_\_\_\_)
16. A place where inland streams and rivers meet ocean water (paragraph \_\_\_\_)
17. Milk and milk products (paragraph \_\_\_\_)
19. A piece of earth that can be used for grazing animals or growing crops (paragraph \_\_\_\_)

## WANT TO LEARN MORE?

Choose one of the links at the bottom of the article to discover more about how dairy farmers are working to protect the environment today and for future generations. On the back of this sheet, write a few sentences about what you learned to share with your classmates.



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