



SCIENCE ON THE FARM ANSWER KEYS



Use these answer keys to guide discussion when reviewing student responses to the activity questions.

FARM TECHNOLOGY

PART 1

1. How do robotic milking machines benefit farmers?

Robotic milking machines allow cows to be milked at regular intervals with little human labor, saving the farmers time to focus on other tasks and greatly reducing their labor costs. The machines are more efficient, so they increase overall milk yield.

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

The sensors track data such as how much food each cow is eating, how often they are milked, how long they are milked, and their preferred milking pace. Sensors on the milking machine detect the location of the teats to make sure they latch on comfortably.

3. Why do the cows choose to be milked?

Cows enjoy the more flavorful feed available in the milking stall. Also, frequent milking is more comfortable for cows.

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

Farmers have more time to spend interacting with the cows and managing their health. They can use the information collected from the transponders to understand each cow's unique needs and to track any changes that might indicate a change in the cow's health.

PART 2

Precision farming is the use of digital technologies to improve farm management. The tools listed below can help increase efficiency and accuracy in all steps from planning through harvest.

Students should note that all these tools cut costs for the farmers, which leads to lower prices at the grocery store – so, they ultimately provide greater access to nutritious foods for more families. Precision farming also reduces the environmental impact of farming because more accurate measurements of soil health allow farmers to use fewer pesticides, commercial fertilizers, and chemicals across the board, and only where needed. Students should also provide examples, such as:

Global Positioning Systems (GPS)

Used to help farmers map their fields, guide farm equipment in the field, and check crops.

- Reduce labor costs and enable work to be done on off-hours or when labor is unavailable
- Help maximize and better plan usage of fields
- Help farmers plan for and protect against weather events
- Allow for direction of crop dusters and aircraft sprayers without human “flaggers” needing to be present

Geographic Information Systems (GIS) & Sensor Technology

Used to help farmers analyze soil conditions, estimate their harvest, and determine where and how much fertilizer and/or pesticide they need to apply. Students can read more here: <https://smallfarms.cornell.edu/2017/04/use-of-gis/>.

- Reduce costs of irrigation, fertilizer, and/or pesticides used by pinpointing specific areas where they are needed
- Reduce environmental impact by minimizing tilling and pesticide use
- Increase profits through better estimation of harvest times and yield, and faster remediation of issues like erosion and insect outbreaks
- Help farmers plan which crops to grow, and where, in order to best maintain the soil
- Allow for more effective planning by providing projections of current and future fluctuations in precipitation, temperature, and crop output

Drones/Robots

Used for milking and feeding cows and to plant seeds, weed, irrigate, and harvest crops.

- Reduce costs and reliance on labor for tasks that are time-intensive
- Provide greater efficiency in feeding cows and harvesting crops, and more evenly disperse water and seeds
- Increase health of crops by providing real-time, accurate data about soil health



SCIENCE ON THE FARM ANSWER KEYS (continued)



FARM BIOLOGY

Selective Breeding and Genetic Engineering

Similarities: Both processes alter the DNA of an organism to create a new organism with different genetic traits.

Differences: Selective breeding operates through natural reproductive and growth processes. Genetic engineering operates by scientific manipulation of an organism's DNA.

How does biotechnology on dairy farms support people's nutritional needs?

Biotechnology allows dairy farmers to grow more feed crops using the same amount of land, water, and other natural resources. These crops make up a large part of the cows' diet, which is carefully designed by nutritionists to keep the cows healthy and productive, while continuing to reduce farmers' costs. The result is that more people have affordable access to nutritionally-rich milk and dairy products.

Follow-Up Activity Idea: To complete this lesson, as a discussion or writing project, have your class brainstorm other nutritional concerns that biotechnology may someday address.



SCIENCE ON THE FARM



FARM ECOLOGY

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.	Energy is needed to manufacture commercial fertilizers and transport them to farmers. Using manure from the farm reduces energy consumption and costs.	Many commercial fertilizers need to be mixed with water, but cow manure contains water that helps fertilize the fields.	Using manure to fertilize crops makes it a resource rather than a waste product.	Cow manure is a natural fertilizer that feeds crops. Manure application also provides carbon and nutrients to the soil, and increases soil productivity.	Compost at home and use that compost to fertilize your garden, trees, shrubs, etc.
2. Methane digesters use the gas given off by cow manure as fuel to generate electricity.			When released to the atmosphere, methane is a potent greenhouse gas. But when methane is used to generate electricity, it produces water and carbon dioxide, a less potent greenhouse gas. In addition, methane does not produce many of the potentially harmful pollutants released by other energy sources, such as coal and oil.		Conserve energy at home. Turn off lights and appliances when not in use, use energy efficient light bulbs, etc. (See https://www.alliantenergykids.com/UsingEnergyWisely/SavingEnergyAtHome for numerous other suggestions.)

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SCIENCE ON THE FARM



FARM ECOLOGY ANSWER KEY (CONTINUED)

Sustainable Farming Practice	A. Conserves Energy	B. Conserves Water	C. Reduces Waste and Pollution	D. Builds Soil Health	E. What I Can Do
<p>3. Some dairy farmers use a device called a plate cooler to cool the milk as it comes from a cow. Cold water passes straight from the well through a 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.</p>	<p>By using a plate cooler and transferring heat from the milk to the cold water, it takes less energy to heat the water for cleaning equipment and less energy to cool down the milk in the bulk tank.</p>	<p>Water is used over and over instead of drawing fresh water for each activity. By utilizing the plate cooler water elsewhere on a farm, for example for the cows' drinking water, farmers use less water.</p>	<p>As it goes through the barn, the water may pick up things like manure from the barn floor. When applied to fields, the manure in the water serves to fertilize crops, thereby making it a resource rather than a waste product.</p>		<p>How can you conserve water? Turn off the faucet when brushing your teeth, take shorter showers, collect rainwater to water indoor plants.</p>
<p>4. Field cover crops keep soil and nutrients in place and reduce runoff.</p>		<p>Helps keep streams flowing free and clean. Also improves soil health and soil porosity. The soil can hold more rainwater, reducing the need for additional irrigation.</p>	<p>Vegetation and groundcover help to filter pollutants such as pesticides and sediment from field runoff.</p>	<p>Reduced runoff and erosion helps keep nutrients in the field where they belong instead of washing away with rain. This, in turn, increases soil quality for the following season. Also improves soil's ability to retain water and benefits the soil microbial community.</p>	<p>Participate in events organized to plant vegetation along stream banks, lakefronts, etc. Plant native vegetation in your yard, school grounds, etc. Some schools and homeowners construct rain gardens (www.epa.gov/soakuptherain/soak-rain-rain-gardens).</p>

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SCIENCE ON THE FARM



FARM ECOLOGY ANSWER KEY (CONTINUED)

Sustainable Farming Practice	A. Conserves Energy	B. Conserves Water	C. Reduces Waste and Pollution	D. Builds Soil Health	E. What I Can Do
5. Solar panels on barn roofs generate electricity for use on the farm.			Solar power does not emit greenhouse gases or other air pollutants.		Conserve energy at home. Turn off lights and appliances when not in use. Use energy efficient light bulbs, etc. (See https://www.alliantenergykids.com/UsingEnergyWisely/SavingEnergyAtHome for numerous other suggestions.) Consider using solar power for your home.
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.	Using these materials reduces the need to truck in other bedding materials, or at least reduces the number of necessary shipments due to reuse on the farm, thus reducing fuel consumption and costs.		Keeps these materials out of landfills.		How can you recycle beyond what your town may already require? Can you use the back side of printed papers for note-taking instead of a fresh sheet? Can you start a home compost pile with food waste to help feed your garden?
7. Orange peels, cotton seeds, and other leftovers are mixed with grain to provide nutritious cow feed.			Keeps these "leftovers" out of landfills.		Compost "leftovers" at home and use that compost to fertilize your garden, trees, shrubs, etc.