



# Conserve Water for Food

## Middle School Presentation and Interactive Slides

### Background

The food science discipline encompasses all scientific aspects for the development, production, processing, packaging, and distribution of foods. Food scientists study the biology, chemistry, and engineering design for food systems to enhance product safety, quality, stability, nutritive value, accessibility, affordability, and sustainability. These efforts apply to food for both humans and companion animals.

Food safety is paramount and widely realized in the United States. However, illnesses occur due to unintentional contamination that can occur throughout production, processing, and final consumer handling. The U.S. Centers for Disease Control and Prevention (CDC) estimates 48 million foodborne illnesses occur in the U.S. annually.

Foodborne illness is typically characterized by gastroenteritis, symptoms of which include nausea, vomiting, diarrhea (may be bloody), abdominal pain, and flu-like symptoms, although some foodborne microorganisms and their toxins can affect other bodily systems including the hepatic, renal, reproductive, and neurological systems. Illnesses can be short-lived and self-eliminating; however, some can be severe and result in hospitalization, long-term sequelae, or even death depending on individual vulnerability, exposure, and pathogen characteristics.

Many of the microbial pathogens associated with foodborne illness can be found in the intestinal tract and fecal waste of infected humans and animals. Foodborne pathogens are often zoonotic, transmissible between humans and other animals. Some microorganisms that cause disease in humans may be carried asymptotically by an animal. Foodborne pathogens are generally transmitted the fecal-oral route, meaning pathogens are shed in the feces of an infected individual and enter the next individual through the oral cavity, generally through consumption of fecally-contaminated food or water. Bacteria, viruses, and parasites can persist in food, water, and the environment for days to months to even years depending on the conditions and microbial characteristics. Bacteria can replicate to increase in number in food and environmental matrices that support their growth. Conversely, viruses and parasites can persist in the environment, but they grow and replicate only in hosts.

Foods that do not receive a proper terminal microbial inactivation treatment such as thermal processing may be particularly vulnerable for transmission of pathogens. For example, raw agricultural commodities contaminated with microbial pathogens have been associated with foodborne illness outbreaks caused by bacteria, parasites, and virus such as *Escherichia coli* O157:H7, *Cyclospora cayetenensis*, and human norovirus, respectively.

Pathogens can be inadvertently introduced to food products through infected food handlers, contaminated food contact surfaces, and contaminated environmental sources such as soil and water. To minimize risks of contamination, guidelines such as Good Agricultural Practices (GAPs) and regulations such as the Produce Safety Rule (PSR) of the Food Safety Modernization Act (FSMA) have been instituted for the production of produce. One of the regulatory requirements includes evaluation of the microbiological quality of water used to irrigate food crops.

Sources of irrigation water can include ground water and surface water (lakes, ponds, streams), although availability of these traditional water resources have become strained due to droughts and contamination. As a result, research efforts to safely and sustainably recycle water for food production has become a research priority.

In order to evaluate the quality of water to be used for irrigation of food crops, environmental water is collected and transported to a laboratory to be tested for the presence of bacteria typically found in the intestinal tracts of humans and other animals. The bacteria that are quantified are known as fecal coliforms and include *Escherichia coli* (*E. coli*). There are many types of *E. coli*. The bacterial species includes generic *E. coli* which is part of a healthy intestinal microbiome and does not harm the host; whereas other strains, such as *E. coli* O157:H7, can cause severe illness. Fecal coliforms are often quantified in water tests as an indicator of potential fecal contamination of water; however, their presence does not necessarily indicate that pathogens are present in a water sample. Analyzing water for the presence of pathogens requires more extensive and time-consuming laboratory tests.

## Educator Presentation Slides and Student Interactive Slides

The educational resource is provided in two formats including: 1) a slide presentation for educators to deliver and discuss the content with a group of students, and 2) a set of interactive slides for self-guided work by students. Each format addresses the same learning concepts and visuals. The interactive slide set provides for students to demonstrate understanding by interacting with the content by moving embedded shapes to identify decisions related to risk assessment, entering reasoning for decisions in boxes, and showing mathematical computations related to data. Students' interactions with the slides also serve as an assessment tool for the educator.

## Education Content Standards Supported

- **Science (Next Generation Science Standards)**
  - Middle School Life Sciences: Structure, Function and Information Processing
  - Middle School Earth and Space Sciences: Weather and Climate
  - Middle School Earth and Space Sciences: Human Impact
  - Science and Engineering Practices
  - Cross Cutting Concepts
- **Mathematics (Common Core)**
  - Use of mathematical equations to solve real-life problems
- **Social Studies**
  - Geography: Ecosystems, human modification and response to natural environment

- Geography: People affected by physical environment
- Civics: Function and authority of government
- **Health**
  - Evaluate practices to reduce health risks
  - Actions of communities impact health of individuals
  - Environment impacts individual health
- **English Language Arts (ELA) (Common Core)**
  - Reading standards for Informational Text

## Learning Objectives

The educational resources support cross-curricular instruction on issues surrounding the availability and safety of environmental water needed for food production. This resource will support student understanding of the following:

1. The importance of fresh water from environmental and recycled water sources for production of food crops
2. The roles of environmental water, plants, animals, and microorganisms in disease transmission
3. The generation and use of data to inform decisions related to provision of safe irrigation water

## Lesson Essential Concepts

1. Water is critical for food production and is obtained from environmental water bodies such as streams and ponds as well as reclaimed water sources.
2. Contaminated and untreated irrigation water can transfer hazardous biological agents to human food.
3. Environmental water is sampled and tested prior to use for irrigation of food crops.
4. Irrigation water must meet microbiological standards for use on food crops.
5. Technology is used to reduce microbial contamination of irrigation water.

## Recommendations for Use

The educator presentation and student interactive slides are part of a multifaceted set of educational resources that also include animations, water sampling and testing simulations, digital narratives, infographics, and glossary to support learning styles and degrees of active learning of fundamental concepts and their application for addressing societal needs. The resources are complementary but can be used independently. It is recommended the students view the animations for an overview of issues surrounding water use and scarcity. Digital narratives feature researchers and the role of laboratory investigations and laboratory processes used to evaluate water quality. The simulations provide students the opportunity to work through the experimental procedures presented in the digital narratives. The slides illustrate the importance and decisions surrounding water used for irrigation of food crops for either instructor delivery or for student independent investigation.

### Complementary Educational Resources

- Animations  
<https://innovativemedia.nmsu.edu/conserve.html>
- Digital Narratives  
<https://www.udel.edu/academics/colleges/canr/departments/animal-and-food-sciences/affiliated-centers/conserve/digital-narratives/>
- Water Sampling and Testing Simulations  
<https://conserve.nmsu.edu/>

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