

STUDENT GUIDE

ENGAGE LESSON 21



Part 1: Our Motivation

Record what we were trying to figure out that led to this investigation.

- How can we decrease the impacts of the dairy system on the environment?
- What is the dairy industry trying to do to reduce its harm on the environment?
- What are some ways to improve the dairy system?
- How can the dairy system be redesigned to have less impacts on the environment?



Part 2: Stages of Engineering Design

Record what you know about the engineering design process.

The engineering process is about finding a solution to a problem. It is basically like a cycle where we define a problem, define criteria and constraints for solutions, think of possible solutions, test the solutions, measure their performance relative to the criteria and constraints, and iterate on the designs to improve them.

How do you think we can use engineering to help us improve the dairy system to more sustainably provide dairy products for people?

We can use engineering to improve the dairy system. We can identify a problem that exists in the way the system operates to produce dairy products, then design a solution to this problem using the engineering design process. The solution should improve on the existing problem to help make the system more efficient.





Part 3: Defining the Problem by Analyzing Costs and Benefits of the Dairy System

Review your artifacts from previous lessons and use them to list all the benefits, costs, and risks of the dairy system as a whole. Record what you find in the table below.

Label each of the benefits, costs, and risks you described as economic, social, ethical, environmental, or geopolitical.

Benefits	Costs and Risks
Food production and food security - social Low-cost products – social/economic Readily available dairy products-social Improving rural livelihood-social/economic Nutritious food for people – ethical/social	Air pollution from manure - social/environmental Use of pesticides and herbicides in raising crops - environmental Greenhouse gasses emissions from cattle, transit, Waste in packaging and processing - environmental Improper land management practices - environmental Losses of biodiversity - environmental Manure and fertilizer runoff in raising crops - environmental. Use of pesticides and herbicides in raising crops

Use the list of costs and risks to define the problem that you want to set out to design a solution for in this module.

I think that the greenhouse gas emissions from cattle is the problem I want to solve.



Part 4: Selecting and Defining Problems

Complete the Problem, Mechanism, and Impact Analysis for the problem you have defined.

- **Problem:** Describe the specific risk or problem associated with the dairy system.
- **Mechanism:** Identify the underlying mechanism or cause responsible for the problem.
- **Impact:** Explain the potential consequences of solving the problem. How will a solution to the problem improve the system?

Describe the PROBLEM	Explain the MECHANISM	Identify the IMPACT
Dairy cattle contribute methane to the atmosphere.	When dairy cattle eat grass or feed, they digest the food and produce greenhouse gases from their digestion. These gases go into the atmosphere from their burps. In the atmosphere, they contribute to the greenhouse effect, raising the average surface temperature of the Earth.	If we reduce the greenhouse gas emissions from the cow burps, we could reduce the total amount of greenhouse gas emissions from the agricultural and dairy industries, which could lead to less temperature rise due to the greenhouse effect in the future.