STUDENT GUIDE
ELABORATE LESSON 5

Food and Agriculture Center for Science Education

Part 1: Our Motivation

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

So, I think I understand the steps and process of dairy getting to my table, but I am still not sure about the environmental impacts of those steps. • How does [component of the system] impact the environment? • What are the downsides of [component of the system]?

Part 2: Summarize Information About Parts of the Dairy System

Share your initial ideas about the benefits and downsides of the dairy production system. Consider specifically:

- On a larger scale, what benefits do we receive from the current dairy food system?
- What are some of the drawbacks or downsides associated with the dairy system?

Remember to think critically and write down your thoughts and questions in each corresponding section of the chart.

Benefits	Drawbacks
We get dairy food without having to raise cattle ourselves. We are able to get a variety of dairy products easily at the store. The dairy system has innovated to feed the general public and meet the demand.	We don't know exactly where our milk is coming from. The dairy system has a lot of trucks involved; I wonder if that impacts the environment. I wonder why there are so many steps to the system. Maybe the cows don't get to live their best lives.

Part 3: Obtaining Information from Texts

Complete the graphic organizer below to help you define one of the following terms: economic, social, environmental, and geopolitical.

Definition	**Characteristics**
Economic: Transactions of goods, services, and money.	Spending money, cost of goods, financial considerations
Example	**Non-Example**
The cost of the machinery in the milking process, the cost of the feed for cattle	The social relationships between people

Record the definitions we agree on as a class.

Economic: Transactions of goods, services, and money Social: The interactions between people and the organization of society Environmental: The impacts on the natural world, including plants, animals, and their habitats Geopolitical: The interactions between states, nations, or other groups.

Read the section of the text that you chose, and annotate any economic, social, environmental, and geopolitical costs, risks, and benefits that you find. Then, meet with your jigsaw group and summarize the different costs, risks, and benefits you found in the table below.

Economic	Social
Costs: Irrigated agriculture and livestock production require increasing volumes of water. Lactating cows require considerably more drinking water each day than goats, sheep, camel, chickens, or swine. Risks: Livestock keeping, and production provide economic opportunities around the word, including employment and income generation, although there may be fewer opportunities in higher-income regions due to intensification and consolidation within the sector.	Costs: Dairy farming has been associated with significantly increased risk of injury in several different countries. Injuries and fatalities are often associated with heavy machinery and vehicle operation, livestock handling, and manure management systems. Risks: The so-called “farm effect” has been extensively documented, but it is not clear how exposure to a farm environment during childhood might modify the risk for asthma, atopy, and atopic disorders. Neither the specific protective factors of farm exposures, nor the underlying immunological mechanisms have been conclusively determined.

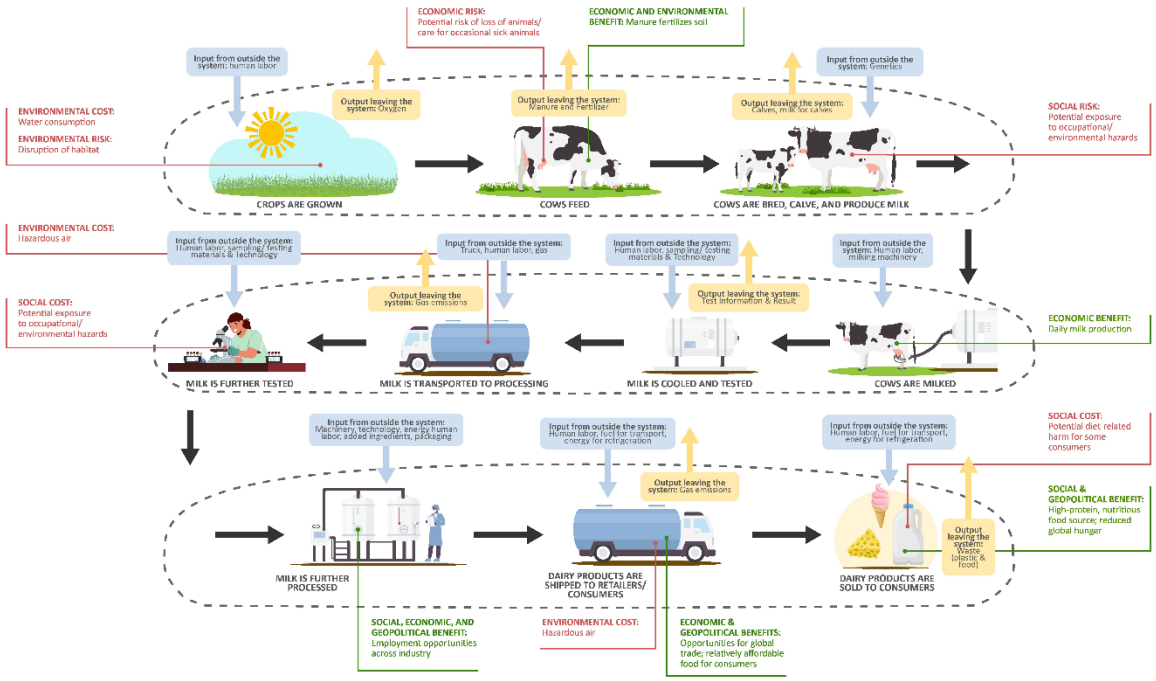
Benefits: Livestock can provide power for transportation or be used in place of farm equipment for crop production. Approximately two billion people in lower-income nations rely on livestock for draft power and transportation.	Benefits: Dairy cattle can provide milk and dairy products that are an important source of protein, vitamins, and minerals. Dairy cattle are also an important source of meat.
Environmental	Geopolitical
Costs: Dairy cattle have a major impact on water use and availability, water quality, hydrology, and the health of aquatic ecosystems. For example, in the US, livestock accounts for approximately 55% of soil erosion, 32% of nitrate loading to freshwaters, and 33% of phosphate loading to freshwaters. Livestock production may also be the single largest sectoral source of water pollution. Risks: Pesticides are commonly used in agriculture production systems, and many have been associated with a number of different adverse human health impacts. Certain gases emitted on dairy farms can cause respiratory symptoms in humans (from animals, animal waste, fodder, and bedding material). Benefits: Livestock manure can be used to improve or maintain soil fertility and contribute to greater crop production for food and additional income generation. Animal manure supplies around 15% of nutrients applied as crop fertilizer globally.	Costs: The International Labour Organization estimates that approximately 170,000 of the 355,000 workplace fatalities that occur worldwide each year involve agricultural workers. Risks: Waterborne transmission of bovine zoonotic pathogens has been documented for several pathogens and presents and important public health risk in both lower- and higher-income nations. Benefits: Agricultural development can benefit human health by increasing food availability and security, and improving overall nutrition, particularly in lower-income nations. In some areas manure is used as a solid fuel or for the generation of biogas. Dung can also be used as a building material and is often a marketable commodity.

Part 4: Revise Your Dairy System Model

Use the evidence that you have gathered throughout this lesson to revise our class consensus dairy system model to help us better understand our Driving Question, "*What is the impact of the dairy system on the environment*?"

In your revised model, be sure to:

- Identify if the costs, risks, and benefits are associated with social, economic, environmental and/or geopolitical impacts.
- Describe the impacts of the dairy system that extend beyond its boundaries by drawing arrows out of the system.



Reflect on your model. What do you see about the intent of the design of the dairy system and the tasks it accomplishes? What are the unintended consequences of the system design? In your response, be sure to:

- Describe the task the design of the dairy system was intended for.
- Describe the economic, social, environmental, and geopolitical costs and risks as well as benefits of the system.
- Describe how the system boundaries help you understand the impacts the dairy system has on the environment.

The dairy system was created because humans needed to get milk and they couldn't do it like they did in the past when many people owned cows. Now, the system is set up so, if they want, everyone can easily and reliably get dairy products at school, restaurants, or stores. Unfortunately, I am seeing that this system has bigger impacts outside of the system. There are economic, social, and environmental risks and not just benefits. For example, transportation is required for milk to travel from farm to processing and then to customers. This releases a lot of greenhouse gases into the atmosphere. This doesn't just impact the system, it impacts the health of people, animals, and plants, and it impacts the earth as a whole. It is important for us to consider the impacts that extended beyond the boundaries of the system to identify ways that it can be improved. The changes that have a direct impact on the system we are analyzing could be implemented first to make a big impact.