TEACHER GUIDE
ENGAGE LESSON 15

Food and Agriculture Center for Science Education

Module Question: *What impact does the dairy production system have on biodiversity?*

What We Figure Out:

We realize there is more to the dairy food system outside of product creation. We observe a Module Phenomenon about the way the dairy system is constructed and how that might impact local wildlife. We think there may be parts of the system that impact the environment and ecosystems, but we aren't sure exactly what impacts it has.

3D Learning Objective:	**Time estimate:**	**Materials:**
Students develop initial models about the effects of the dairy food system on biodiversity. Students evaluate the strengths and limitations of their peers' models.	30 minutes	Lesson 15 Student Guide Video #1: Forest to Farm Video #2: Land to Dairy

Targeted Elements

SEP:

MOD-H4:
Develop and/or use multiple types of **models to provide mechanistic accounts** and/or predict phenomena, a**nd move flexibly between model types based on merits and limitations.**

DCI:

Pre-Assessment
LS4.D-H2:
Humans depend on the living world for the resources and other benefits provided by biodiversity. **But human activity is also having adverse impacts on biodiversity through** overpopulation, overexploitation, **habitat destruction, pollution**, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to

CCC:

Pre-Assessment:
CE-H3:
Systems can be designed to cause a desired effect.

	supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.	

Directions

Part 1: Our Motivation

USE OF PHENOMENA

Students ended the previous lesson by asking what questions need further investigation to understand the Anchor Phenomenon and revisiting the Driving Question Board. The next set of media claims from the Anchor Phenomenon that students will investigate are Claims 11 and 12. These claims also correspond to the question category from the Driving Question Board about impacts on biodiversity. The next question category from the Driving Question Board to explore is about Biodiversity and Environment. Therefore, in this module, students will start by observing an investigative phenomenon that asks students to figure out how the construction of the dairy system affects nearby plants and animals. Figuring this investigative phenomenon out will help students progress on their questions about the overall Anchor Phenomenon for the unit: how the dairy system impacts the environment.

To introduce this module to students, return to the class list of media claims. Ask students what media claims seem the most pressing to investigate next. Build off student responses to point out the claims related to biodiversity. Then, return to the Driving Question Board and revisit the questions in the Biodiversity and Environment category. Have students read off selected questions to highlight student questions about how dairy impacts plants and animals and biodiversity overall.

DCI SUPPORT

In middle school, students learned that changes in biodiversity can influence humans' resources and ecosystem services. This unit builds on this knowledge in that students figure out that human activity has adverse consequences on biodiversity and that sustaining biodiversity requires responsible management of natural resources. This lesson serves as a pre-assessment of students' prior knowledge of the impacts of technological systems on biodiversity. Throughout the rest of this module and into module four, students will figure out how changes in biodiversity can have consequences for humans and strategies for protecting biodiversity.

Students can record these questions or the media claims they are investigating on their Lesson 15 Student Guide Part 1: Our Motivation. This will help students understand how this lesson connects to what they were trying to figure out about the Anchor Phenomenon. In student responses, listen for the following ideas:

- How does the dairy system impact plants?
- Are dairy cattle a danger to certain wildlife species?
- How do the buildings and vehicles used in this system impact plants and animals?

Build off student questions and the selected media claims to confirm that students will set out to figure out how the production of dairy affects biodiversity.

Part 2: Observing the Investigative Phenomenon

STUDENT SUPPORT

To help connect the Module Phenomenon to students, you may choose to facilitate a conversation to connect the environment and biodiversity to students' lives. Use this opportunity to connect this topic to students' homes, neighborhoods, communities, and cultures as appropriate. Seek out and use students' current funds of knowledge from their own experiences. Consider asking questions such as:

- Are there dairies in our area or state? How do you think they impact local wildlife?
- What does biodiversity look like in your neighborhood and community?
- Why do you think it is important to understand biodiversity and how human activities are influencing biodiversity?

To start this module, show the students two videos about how dairy systems can be built. The first video shows how land is cleared to make room for either buildings or crops to feed cattle. The second video shows how dairy barns and other buildings are built. Show the dairy videos without sound.

Video #1: Forest to Farm
Video #2: Land to Dairy

As students watch, ask them to record what they observe in their Lesson 15 Student Guide Part 2. Then, use a Think-Pair-Share Strategy to have students share what they noticed from the video.

1. Students are given time to think independently about their responses.
2. Students find an elbow partner.
3. Students take turns sharing their thoughts with their partner. Each student should be given time to respond.

In student responses, look for the following ideas:

- The videos seem to show how land is cleared to make room for dairy cattle grazing or dairy farm buildings.

Next, ask students to share why they think the design of the system was done in this way and if the design was intended to take into account the effect on nearby plants and animals. Use a Think-Pair-Share for students to share their ideas. In student responses, look for the following ideas:

- The construction of the dairy buildings was meant to make the production of dairy products more efficient and to give the cattle shelter.
- The land might be cleared for cattle to eat the grass or to grow crops to feed the cattle.
- The clearing of land might hurt plants and animals who live there.
- A lot of different plants must have died when clearing the land.
- After buildings are built, plants and animals can't live in that space anymore.

CCC SUPPORT

CE-H3: Systems can be designed to cause a desired effect.

In middle school, students analyzed the design of systems by determining that systems can have sub-systems and be a part of larger systems. In this module, students build on this idea by using their knowledge of a system's design to identify the function of the system, including the relationship between its design and the intended and unintended effects the system design has on the environment. Here, students are using this element to describe the intent of the construction and design of the dairy system. Students consider if the intended effect of the dairy system, to build infrastructure to produce dairy products, has considered effects on biodiversity. Throughout the rest of the unit, students will figure out that the system was not designed to take biodiversity into account (Module 3) and will find solutions to redesign the system to produce new effects, including protecting biodiversity (Module 4).

Build off student response to confirm that the construction of the dairy system was intended to support the production of dairy products and not to take into account nearby plants and animals. After agreeing on these observations, introduce the Module Question: "*What impact does the dairy production system have on biodiversity?"*

STUDENT SUPPORT

If students need additional support assessing the impacts of the construction of the dairy system on plants and animals, consider:

- Asking students to reflect on their experiences with construction sites and how they impact plants and animals.
- What have you noticed when a new building is constructed, or excavation of the land is happening?

Part 3: Creating and Sharing Initial Models

Students will create an initial model showing how they think the construction of the dairy system impacts nearby plants and animals. They will also reflect on why this impact matters. Students may develop this model in any format they prefer in the space in their Lesson 15 Student Guide in Part 3. Students may choose different model formats, and the class will discuss the merits and limitations of each model type.

Share with students that their models should begin by showing the phenomenon we are focusing on the construction of the dairy system. Then, the models should show how this impacts nearby plants and animals and biodiversity.

STUDENT SUPPORT

Allow students time to develop their models. If students need additional support in choosing a model type to use, consider:

- Providing students with a list of different models to choose from, including a pictural model, concept map model, or a systems model.
- When students are getting started creating models, prompt them to use the responses they shared when observing the investigative phenomenon to get started.

Example Student Model

As students work on their models, approach each group, and observe student work. Prompt students with questions such as:

- How did you come to that decision?
- What do you mean by _____? Tell me more about that.
- What prior knowledge or experiences did you use to create your model?

- Which model type did you choose to use? Why?
- What are you trying to show in your model?
- How does clearing land impact wildlife? How do we know this? How did you show that in your model?

After students create their models, have students engage in a Stay and Stray Strategy to share their models with their peers.

1. After small group models are complete, ask groups to have one person "stay" at their table with the model they created to explain the model to classmates from other groups.
2. The rest of the team members "stray" to the other groups to learn about the other group's models, allot about 2 to 5 minutes per rotation.
3. During the rotation time, students can ask questions to help gain clarity on the decisions they made. Students can ask questions such as, "What parts of the models do we seem to agree on?"
4. At every signal to rotate to a new group, a different team member goes back to stay with the group's work, and everyone else (including the person who first stayed) moves on to view the next product. This allows everyone to see all but one product.
5. After visiting all groups, initial small groups regroup and share new information gathered.
6. Groups discuss new ideas and decide whether or not they will integrate them into their work.

As students share their models and return to their groups, circulate the room to listen to student conversations, ask probing questions, and observe and record the strengths and limitations of each other's models.

FORMATIVE ASSESSMENT OPPORTUNITY

Students develop initial models about the effects of the dairy food system on biodiversity. Students evaluate the strengths and limitations of their peers' models.

Assessment Artifacts:

- Students' initial models of how the construction of the dairy system can impact local wildlife (Lesson 15 Student Guide Part 3 Creating and Sharing Initial Models).
- Students' reflections on strengths and limitations of their own and their peers' models.

Look Fors:

- Students create a model of how the construction of the dairy industry impacts biodiversity. (MOD-H4, LS4.D-H2)
- Students evaluate the strengths and limitations of different types of models (MOD-H4)

- Students' models show how the intent of the construction of the dairy system can have effects on nearby biodiversity (LS4.D-H2, CE-H3).

Assessment Rubrics:

	Emerging	Developing	Proficient
Sample Student Response	Model shows: • The construction of the dairy system and loss of plants and animals.	Model shows: • A loss of local plants and animals as a result of the construction of the dairy system. • A clear link between clearing land for space for growing crops and dairy infrastructure and a loss of plants and animals, such as via loss of habitat. Model evaluations shows: • A comparison of the models without naming strengths and limitations.	Model shows: • A loss of local plants and animals as a result of the construction of the dairy system. • A clear link between clearing land for space for growing crops and dairy infrastructure and a loss of plants and animals, such as via loss of habitat. Model evaluations shows: • Strengths of models that clearly show a link between building of the dairy system and a loss of local plants and animals. • Limitations of models that do not clearly show this connection.
How to Achieve This Level	Student completes 0 out of 3 Look Fors	Student completes 1-2 out of 3 Look Fors	Student completes 3 out of 3 Look Fors

To Provide Additional Support for Students:
As students work, if students are struggling to identify the strengths and limitations of each other's models, consider providing the following prompts to facilitate additional questions:

- What does this type of model show that others do not? What does it not show?
- Does this type of model clearly show how the construction of the dairy system impacts biodiversity?
- We have figured out a lot about different systems affected by the dairy food system. What new systems were introduced in the videos we watched? What new questions do we have about these systems?

- What effect is the dairy system designed to have? What is an unintended consequece of its design?

STUDENT SUPPORT

Using the Stay and Stray Strategy allows students to compare and contrast their models with other students. This will help them observe the various ideas around the room to help open discussion on the topic and agree on and integrate new ideas. This allows them to self-evaluate the strengths and weaknesses of their model before implementing edits.

After the Stay and Stray Strategy, hold a whole-class share-out of the revised models. After one student from a group shares their group's model, allow students from other groups to ask probing questions. These questions should be focused on gathering more information from the student who helped create the model. This could sound like:

- What did you see happen in the video that led you to this model?
- Tell me more about this part of your model.
- Do you agree with ____ in the model?
- This part of the model seems different than what other groups shared. Why is that?

CCSS SUPPORT

SL 9-10.3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. This standard is met as students listen to their peers. They should be listening to understand their perspective before moving into the Class Consensus Model.

Bring the class back together and have selected student groups share their models with the class. Select student groups who chose different forms of models to represent their ideas. Ask students to evaluate the strengths and limitations of the different kinds of models that their peers have chosen. Students should agree that:

- Different model types show this phenomenon more clearly than others. For example, flowcharts or concept maps can show the relationships between ideas clearly. Models that show pictures make it a bit more difficult to see how one cause (the construction of the dairy system) leads to other effects on nearby wildlife.

SEP SUPPORT

MOD-H4: Develop and/or use multiple types of **models to provide mechanistic accounts** and/or predict phenomena, **and move flexibly between model types based on merits and limitations.**

In the second module of this unit, students developed their proficiency with this SEP element. Here, students are using their understanding of how to evaluate the merits and limitations of different types of models to analyze the different types of models their peers have produced.

Part 4: Asking New Questions

As a final step in this lesson, students will create a new list of questions in their Lesson 15 Student Guide in Part 4 that can help them determine additional information they need to know about the impact of the construction of dairy production systems on nearby plants and animals. Add these questions to the Biodiversity and Environment category of the Driving Question Board so they can continue to be referenced in the coming lessons.

To facilitate students asking questions, use the Question Formulation Technique.

1. With their group, students take 5 minutes to brainstorm questions about what they need to know about how dairy foods are created and distributed.
2. Students then look at all their questions and choose the 3-5 questions they think are most important to be answered to help them figure out the Module Question.
3. A representative from each group will then share their prioritized questions with the whole class. As students share their prioritized questions, they will add them to the Driving Question Board.

LOOK FOR

In student responses, listen for the following questions:

- How does the set-up of the dairy system impact the local ecosystem?
- What habitats are destroyed by the dairy industry?
- Does the dairy industry do anything to help plants and/or animals other than cows?
- What ecosystems can the dairy system impact?
- What ecosystems do the cows interact with? Is that interaction beneficial or costly?