LESSON 5: WHY DON'T WE JUST GROW MORE?

THE BIGGER PICTURE

In Lesson FS1, students were asked to respond to a formative assessment question: "Is the answer to the growing lack of food security in a growing population simply to grow more food?". Students will revisit their responses and will be using today's lesson to add to or modify their answer and justifications by exploring the issue of why solving the global food crisis by simply growing more food is not as easy in reality as it is on paper. In Lesson FS4, students started to visualize food security as a system. They will continue to explore the idea that when nodes are interacting in a system, modifying one node can have far reaching consequences for the entire system. In this lesson, students will focus on the stakeholders introduced in Lesson FS3, by analyzing an article and evaluating the impact that possible solutions to global food insecurity will have on stakeholders.

OBJECTIVES

What students learn

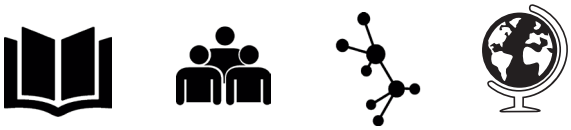
Students recognize that solving the global food security crisis is complex and that decisions made to address it will affect all stakeholders. Students also learn some network nodes have more influence than others.

What students do

Students work in groups to analyze The Great Balancing Act, a working paper from the World Resources Institute. In partners, students analyze the impact each stakeholder would have in each of the suggested scenarios and connect the concepts to the network.

TIME

50 minutes - 1 class period



STANDARDS

- NGSS PE: HS-LS2-7; DCI: LS2.C; SEP: CEDS; CC: S&C
- NGSS PE: HS-LS4-6; DCI: HS-LS4C & HS-LS4D; SEP: Using Mathematics and Computational Thinking; CC: C&E
- NGSS PE: HS-ESS2-5; DCI: HS-ESS2C; SEP: Developing and Using Models; CC: Energy and Matter
- NGSS PE: HS-ESS3-1; DCI: HS-ESS3A; SEP: CEDS; CC: C&E
- NGSS PE: HS-ESS3-4; DCI: HS-ESS3C; SEP: CEDS; CC: S&C & ETS
- NGSS PE: HS-ETS1-3; DCI: ETS1.B; SEP: Asking Questions and Defining Problems; CC: Influence of ETS
- NGSS HS-ETS1-1; DCI: ETS1.A; SEP: Asking Questions and Defining Problems; CC: Influence of ETS

PREREQUISITES

There are no prior course prerequisites; however, students should have completed the previous lessons in the FS module, as well as the cell phone network activity (Introduction to Systems).

BEFORE CLASS

Print out a copy of the "The Great Balancing Act" article for each student or allow students to access the link electronically. Print out a copy of the Balancing Act Article Chart Analysis Handout for each student. If using the optional reading guide handout, print out 1 copy per student along with 1 copy of the teacher guide to the handout. Students will also need their "Building Your Case" worksheet. Download the Food Securtity Vocabulary PowerPoint. All of the *Modeling Sustainable Food Systems* resources are on the SEE website: see.systemsbiology.net.

TEACHER INSTRUCTIONS

1. **Warm-Up:** Students come up with a definition for the words "ecosystem" and "nonrenewable resource". These vocabulary terms were included as they are one focal point discussed in the article students will be reading. One of the main objectives of the article is to examine how we can provide more food by 2050, while not increasing our impact on the environment. To maintain a balanced, healthy ecosystem, we must decrease our resource use and dependence on nonrenewable resources.

- Show the Food Security Vocabulary PowerPoint for Lesson 5. Have students brainstorm what an "ecosystem" is, and list examples of different ecosystems.
  - Ecosystem definition: the complex of a community of organisms and its environment functioning as an ecological unit.
  - Nonrenewable resource definition: any natural resource from the Earth that exists in limited supply and cannot be replaced if it is used up; also, any natural resource that cannot be replenished by natural means at the same rates that it is consumed.

2. **Critically Evaluating Solutions through Literature Review**

- Ask students to look at their answers to the wrap-up question in Lesson FS1, "is the answer to food insecurity simply growing more food?", and discuss at their table what their response was. Have them decide if they are satisfied with it and ask for volunteers to share out their answers. Let them know that we will continue to evaluate this question of why don't we just grow more food as we analyze an article today and the impact that the various stakeholders have on the problem.
- Place students in pairs to read the article "The Great Balancing Act". It is suggested that they are in the same pairs as they were for Lesson FS3 (Who Cares? Stakeholders!)
- Have students silently read pgs 1-9 making sure to look at the diagrams. There are three objectives the article is built around (page 9): a) the world needs to close the gap between what food is needed today and what will be needed by 2050, b) the world needs agriculture to contribute to inclusive economic and social development, and c) the world needs to reduce agriculture's impact on the environment and natural resources. Let students know that, as a class, we will be looking at the chart on pages 10-13. Instructions for reading and analyzing the chart can be found in the "Analysis Activity with Chart".

TEACHER INSTRUCTIONS CONTINUED

- As they are reading, students need to be underlining with a purpose as well as circling vocabulary words that are important, repeated and defined in the text. Ask students to use the margins of their articles to write a sentence or two summarizing what the author meant or any questions they have about the article. Optional: To reduce time needed to read the article or accommodate students with lower reading ability, teachers can break the text into smaller segments for the students and assign different groups to different sections of the article (jigsaw).
- Once students have read, have them discuss what they discovered with their reading partner. Ask them to begin to formulate an answer to the question, "Why can't we just grow more food?", by writing a few rough sentences that begin to explain their viewpoint based on what they read, and reference back to the article with supporting "facts". They can write their response in their notebook or on a separate slip of paper. The purpose of this is to draw evidence from an informational text so that they can research, analyze and then reflect on their question of "Why can't we just grow more?".
- Possible class discussion questions:
  1. What are the three components that the article mentions that create the "The Great Balancing Act"?
  2. How are the vocabulary terms we reviewed earlier (ecosystem and nonrenewable resources) related to the article?
  3. What impact is agriculture having on the environment and our natural resources?
  4. How can we find balance between feeding a growing population and caring for our environment and natural resources?
- **OPTIONAL HANDOUT IN LIEU OF ANNOTATING THE ARTICLE:** Rather than annotating the article while reading, students can use the optional handout with guiding questions for the article. Please see the The Great Balancing Act- Reading Guide (Student Version) and the accompanying teacher guide titled The Great Balancing Act- Reading Guide (Teacher Version) in the Resources section.

3. Analysis Activity with Chart

- For the following activity, the class will focus on the chart called "A Menu for Sustainable Food Future" (pages 10-13) at the end of the article, which includes options ("menu items") of how to achieve a sustainable, food secure future, with potential impacts (poverty alleviation, gender, ecosystems, climate, and water) identified .
- Prior to looking at the chart as a class, take a moment and review the stakeholders involved from Lesson FS3. As a class, discuss and determine which 5 stakeholders students believe are most impacted by perturbations in the food security network. Note to teacher: there is no right answer here, as long as students can justify their determination. One suggestion is to look at their causal loop diagram from Lesson FS4, for a visual of the system. Once five stakeholders have been identified, this is the list you will use to evaluate the chart at the end of the article. By identifying 5 stakeholders, this gives the class a common set of individuals to compare across all "menu items" and focuses the classes' attention on looking more in depth at how each of these 5 stakeholders is impacted by each "menu item".
- Examples of stakeholders that might be most impacted might be: urban citizens in a developing country, representatives of agricultural supply, Earth's water supply, small farmers in developing countries and the environment. However, any 5 stakeholders can work for this activity, as long as the class is in agreement and students can justify their reasoning for choosing that stakeholder.
- Have students study the chart and discuss as a class, how to read it. In looking at the chart, orient pages 10 and 11 so they are side-by-side, and do the same with pages 12 and 13. To read the chart, refer the the example below:
  - Example: Refer to the first course heading labeled "Hold down consumption". Read horizontally across the chart and you will see a column dedicated to menu item, description, performance against criteria (poverty alleviation, gender, ecosystems, climate, water), comment, food availability and GHG (greenhouse gas) emissions. If the "Increased Food Availability" and "Decreased GHG Emissions" columns have an X below them, that menu item is meeting that need; therefore, if no X is present, that menu item is not meeting that need. Be sure to study the key at the top right of the charts to understand what each icon represents. This is a highly intense thinking skill/analysis activity!
  - For example: using one of the stakeholders from the example above (urban citizens in a developing country) focusing on the first menu item, "reduce food loss and waste". This could have a positive impact on urban citizens in a developing country, because it is a manageable, actionable item that anyone could focus on. This would not only limit the amount of loss of food, but the resources it takes to acquire that food.
- Place students in groups of 2-3 to analyze the chart. Hand out the Lesson FS5 Balancing Act Article Chart Analysis Handout (1 per student). Each group will analyze each menu item on the chart using the 5 stakeholders determined in step 2. Note to teacher: to save time, give each group just a few of the menu items to focus on, then have each group share out what they determined through their analyses to the class so that students can record their information. For each "menu item" they will identify the following and record the information on the handout: a) which one of the 5 identified stakeholders would be impacted the most by that particular menu item b) would they be impacted positively or negatively, c) how would they be impacted (justifying their answer), d) whether or not they agree with the dots on to the right of the menu item (justifying their answer), e) what is the overall impact to food availability and GHG emissions and f) do they agree that it will have the same impact on food availability and GHG emissions as indicated on the chart? They must justify their answer. Note to teacher: See an example answer key, based on the five stakeholders above, developed by the 2017 Project Feed 1010 Ambassadors in the Lesson FS5 resources at see.systemsbiology.net.
- As a class, discuss each of the menu items. Focus on which stakeholder they determined is impacted by each "menu item" and whether that impact is positive or negative. One "menu item" to point out as a discussion point would be, "boost yields through attentive crop and animal breeding". This is a great "menu item" to discuss because all of the performance against criteria are neutral. Focus also on a couple of the "menu items" as well as the link between food availability and GHG emissions (the last two columns) for that "menu item".
  - One suggestion is to focus on the following 4 "menu items": reduce then stabilize wild fish catch, improve the feed efficiency of ruminant livestock, make fertilization more efficient and manage rice paddies to reduce emissions. All of these examples have an impact on either food availability or GHG emissions, but not both. Discuss why this might be the case.

TEACHER INSTRUCTIONS CONTINUED

4. **Building Your Case:** have the students complete the questions for FS Lesson 5 on the "Building Your Case" worksheet. The goal of this activity is to continue building their case to solve the food security crisis in their country, which they will be presenting (as a summative assessment) at a UN summit.
5. **Exit Ticket:** Tell the students that to wrap up the lesson, we are revisiting the concept of ecosystems and nonrenewable resources. Give students time to complete the prompts listed below (from the Lesson 5 slides in the Food Security Vocabulary PowerPoint) in their notebook. Time permitting, students can share out their responses.
    - Show how an ecosystem can be illustrated as a system
    - How would overuse of a nonrenewable resource affect the ecosystem you just illustrated?

MODIFICATIONS

- In the interest of time and/or student skill level, the teacher may wish to break up the article chart into smaller pieces and have each group only analyze a few of the "menu items" and how stakeholders are impacted by them. This will allow the lesson to proceed faster and will not be as overwhelming for students. When the lesson was piloted by interns in 2017, students were broken up into 3 groups and the chart was broken up into three equal segments (~ 5-6 menu items for each group to analyze). See the example of the table filled out and broken up on the SEE website. If students have internet access and computers, they can work collaboratively on a shared digital version of the document rather than filling out physical copies and sharing information later.

RESOURCES

- SEE website: see.systemsbiology.net
    - Food Security Vocabulary PowerPoint
    - Digital version of Balancing Act Article Chart Analysis Handout for modification
    - Example Balancing Act Article Chart Analysis Handout
- Searchinger, T., et al. The Great Balancing Act Installment 1, World Resource Institute, http://pdf.wri.org/great_balancing_act.pdf
- The Great Balancing Act- Reading Guide (Student Version)
- The Great Balancing Act- Reading Guide (Teacher Version)
- Balancing Act Article Chart Analysis Handout

LESSON 5: WHY DON'T WE JUST GROW MORE?

RESOURCES: THE GREAT BALANCING ACT - READING GUIDE (STUDENT VERSION)

As you read The Great Balancing Act, answer the following questions. This will serve as a guide to future class discussions about solutions to the problem of feeding the world's population by 2050.

1. State the three needs that compose the "Great Balancing Act".

2. What are the three environmental impacts that agriculture contributes to?

3. Look at Figure 3. Name two areas of the world that will increase to a higher water stress level by 2025.

4. If all the food produced in 2009 was evenly distributed (calorie wise) to all the people in 2050, it would come up short by _____ kcal per person per day.

5. If the current rate of food loss and waste remained at the same rate in 2050, we would be short _____ kcal per person per day.

6. With an increase demand in food, comes and increase in the demand for crops. The article recommends that we increase the production of crops from _____ trillion kcal per year in 2006 to _____ trillion kcal per year in 2050.

7. In order to balance the needs of the environment with the needs of crop production, crops in the future must be grown without the increased use of _____ and _____. (Name two)

8. The article mentions possible solutions/menu items. What are the three main courses where these menu items would aid in creating a sustainable food future?

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RESOURCES: THE GREAT BALANCING ACT - READING GUIDE (TEACHER VERSION)

As you read The Great Balancing Act, answer the following questions. This will serve as a guide to future class discussions about solutions to the problem of feeding the world's population by 2050.

Teacher Version- Answers in Red

1. State the three needs that compose the "Great Balancing Act".
   1 - close the gap between food available now and needed by 2050
   2 - agriculture needs to contribute to inclusive economic and social development
   3 - world needs to reduce agriculture's impact on the environment and natural resources

2. What are the three environmental impacts that agriculture contributes to?
   Ecosystems, Climate, and Water

3. Look at Figure 3. Name two areas of the world that will increase to a higher water stress level by 2025.
   Students could answer India, China, Great Plains in the US, Central America or Central Africa

4. If all the food produced in 2009 was evenly distributed (calorie wise) to all the people in 2050, it would come up short by _____200_____ kcal per person per day.

5. If the current rate of food loss and waste remained at the same rate in 2050, we would be short _____900_____ kcal per person per day.

6. With an increase demand in food, comes and increase in the demand for crops. The article recommends that we increase the production of crops from ____9,500____ trillion kcal per year in 2006 to ____15,000____ trillion kcal per year in 2050.

7. In order to balance the needs of the environment with the needs of crop production, crops in the future must be grown without the increased use of _____ and _____. (Name two)
   Students could answer scientifically bred seeds, synthetic fertilizers, pesticides, or water use

8. The article mentions possible solutions/menu items. What are the three main courses where these menu items would aid in creating a sustainable food future?
   1st - items that help close the food gap by reducing growth in food consumption
   2nd - items that help close the food gap by increasing food production on existing agricultural land areas
   3rd - items that reduce the environmental impact of food production but do not necessarily lose the food gap (this focuses more on the stress to the environment and the importance of sustainability for future crop production)

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RESOURCES: BALANCING ACT ARTICLE CHART ANALYSIS HANDOUT

COURSE	MENU	WHICH OF THE 5 IDENTIFIED STAKEHOLDERS WOULD BE IMPACTED BY THIS MENU ITEM?	WOULD THEY BE IMPACTED IN A POSITIVE OR NEGATIVE WAY?	HOW WOULD THEY BE IMPACTED? JUSTIFY YOUR ANSWER	STATE WHETHER YOU AGREE OR DISAGREE WITH THE PLACEMENT OF DOTS FOR THE MENU ITEM. JUSTIFY YOUR ANSWERS	WHAT IS THE OVERALL IMPACT TO FOOD AVAILABILITY AND GHG EMISSIONS?	DO YOU AGREE THAT THE MENU ITEM WILL HAVE THE IMPACT INDICATED ON FOOD AVAILABILITY AND GHG EMISSIONS? JUSTIFY YOUR ANSWER
HOLD DOWN CONSUMPTION	REDUCE FOOD LOSS AND WASTE						
	REDUCE OBESITY						
	EAT FEWER ANIMAL PRODUCTS						
	SHIFT MEAT CONSUMPTION AWAY FROM BEEF						
	ACHIEVE REPLACEMENT FERTILITY RATES						
	REPLACE BIOFUEL DEMAND FOR FOOD CROPS						

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COURSE	MENU	WHICH OF THE 5 IDENTIFIED STAKEHOLDERS WOULD BE IMPACTED BY THIS MENU ITEM?	WOULD THEY BE IMPACTED IN A POSITIVE OR NEGATIVE WAY?	HOW WOULD THEY BE IMPACTED? JUSTIFY YOUR ANSWER	STATE WHETHER YOU AGREE OR DISAGREE WITH THE PLACEMENT OF DOTS FOR THE MENU ITEM. JUSTIFY YOUR ANSWERS	WHAT IS THE OVERALL IMPACT TO FOOD AVAILABILITY AND GHG EMISSIONS?	DO YOU AGREE THAT THE MENU ITEM WILL HAVE THE IMPACT INDICATED ON FOOD AVAILABILITY AND GHG EMISSIONS? JUSTIFY YOUR ANSWER
PRODUCE MORE FOOD WITHOUT LAND EXPANSION	BOOST YIELDS THROUGH ATTENTIVE CROP AND ANIMAL BREEDING						
	"LEAVE NO FARMER BEHIND"						
	PLANT EXISTING CROPLAND MORE FREQUENTY						
	IMPROVE SOIL AND WATER MANAGEMENT						
	EXPAND ONTO LOW-CARBON DEGRADED LANDS						
	INCREASE PRODUCTIVITY OF PASTURE AND GRAZING LANDS						

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RESOURCES: BALANCING ACT ARTICLE CHART ANALYSIS HANDOUT

COURSE	MENU	WHICH OF THE 5 IDENTIFIED STAKEHOLDERS WOULD BE IMPACTED BY THIS MENU ITEM?	WOULD THEY BE IMPACTED IN A POSITIVE OR NEGATIVE WAY?	HOW WOULD THEY BE IMPACTED? JUSTIFY YOUR ANSWER	STATE WHETHER YOU AGREE OR DISAGREE WITH THE PLACEMENT OF DOTS FOR THE MENU ITEM. JUSTIFY YOUR ANSWERS	WHAT IS THE OVERALL IMPACT TO FOOD AVAILABILITY AND GHG EMISSIONS?	DO YOU AGREE THAT THE MENU ITEM WILL HAVE THE IMPACT INDICATED ON FOOD AVAILABILITY AND GHG EMISSIONS? JUSTIFY YOUR ANSWER
PRODUCE MORE FOOD WITHOUT LAND EXPANSION	REDUCE THEN STABILIZE WILD FISH CATCH						
	INCREASE PRODUCTIVITY OF AQUACULTURE						
REDUCE EMISSIONS AND OTHER IMPACTS FROM OTHER AGRICULTURE ACTIVITES	IMPROVE THE FEED EFFICIENCY OF RUMINANT LIVESTOCK						
	MAKE FERTILIZATION MORE EFFICIENT						
	MANAGE RICE PADDIES TO REDUCE EMISSIONS						